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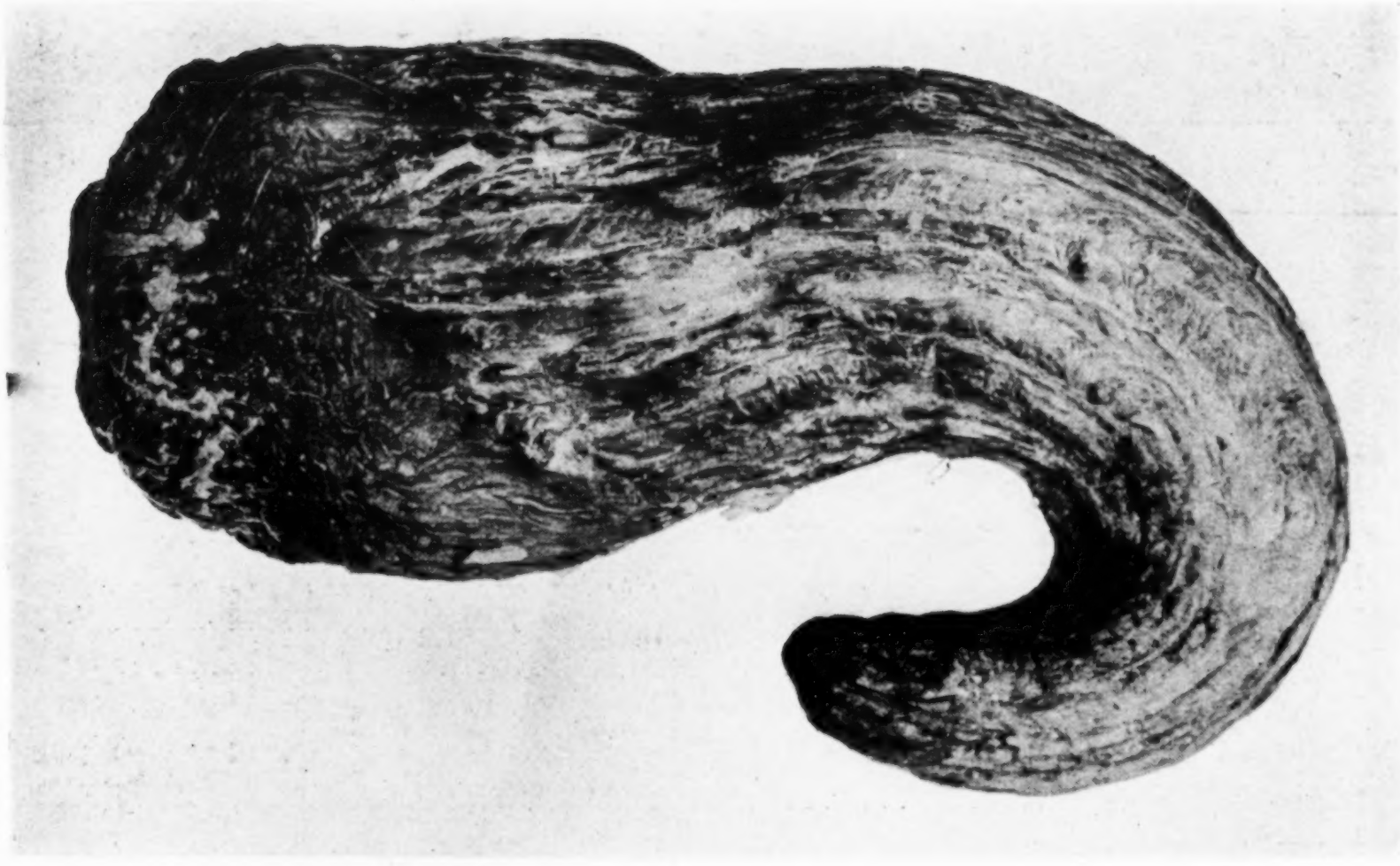

Photograph by John Howard Paine.

A WOMAN WITH HORNS

The above photograph (twice natural size, in order to bring out the detail) shows a horn removed from the forehead of a woman.
Growth started less than 18 months ago.
Many say they have heard of monstrosities like this but never seen them. An active general practice of 35 years has given me opportunity to see many things in this line, but never before have I seen one so well marked and so significant.
The woman from whom this was taken is 78 years old, born in America of German descent, in a family peculiar as to mentality, some members being up to or above normal, others decidedly defective.
This horn was not attached to the skull, but was merely a development of the skin. It was fed by a small spur from the temporal artery, the blood supply being so well developed that profuse hemorrhage followed the operation.
One of the most striking facts in connection with the case is that a similar horn was removed from the opposite side of the face a year ago. The sites of the two scars correspond very accurately; hence horns are bilaterally symmetrical, just as in most animals. (Frontispiece.)

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AMERICA'S FIGHTING STOCKS

Half a Dozen Races Available for War, Each Valuable in Its Way—Brunt of Battle Will Be Borne by Old Americans of Nordic Descent—Officers Nearly all Nordics

IN EVERY American city, bright-colored posters appeal to the youth of the nation to enlist for the war.

Almost without exception, these posters present pictures of clean-cut, tall, fair, long-skulled youths, with every appearance of possessing the qualities of leadership and initiative. This is America's concept of the typical soldier.

If an anthropologist should paint a picture of a typical member of the Nordic race, he would portray just such a man as now appears on the recruiting posters.

This exact identity of the typical United States soldier and the typical Nordic is not a coincidence, nor the result of artistic inventiveness; it is due to the fact that the soldiers of this country have always been Nordic, and will be Nordic at least during the present war, in overwhelming preponderance. Many soldiers will, of course, be found who present the direct opposite of the Nordic characteristics, and for this reason will be more noticed individually than is the common type, but they will not be typical of America's fighting forces.

While the officers of an army built up in time of peace are not chosen primarily for fighting ability, a survey of the ancestral nationality of American army officers is nevertheless of interest. It can be made in a rough way by noting the apparent nationality of the family name. On this basis, 4,233 regular commissioned officers of the U. S. Army were taken from the 1916 *Register* and classified as follows:

Great Britain	89.8%
English	81.0
Irish	3.5
Scotch	4.3
Welsh	.1
Germany	7.7%
France	2.0
Holland	1.6
Scandinavia	1.5
Spanish	.5
Jewish	.1

Even if abundant allowance is made for the inaccuracy of this method, it is evident that more than nine-tenths of the regular army officers are Nordics, nearly all of them Anglo-Saxons. The Mediterraneans are represented by the Welsh and a scattering from other parts of Great Britain, no doubt. The Spanish names in the list belong to Porto Ricans or Filipinos. The French names probably represent Huguenot families (mostly Nordic); the Hollanders are doubtless representatives of the old Dutch families of New York.

The privates, while not so overwhelmingly Nordic, still have for the most part the tall stature and blondness characteristic of the Nordic race. According to calculations made by the Surgeon General's Office, the average infantryman is 67.4 inches in height, with chest girth (deflated) of 34.07 inches, weighs 147.07 pounds and is 30.9 years old.

THE NORDIC RACE

The Nordic race probably took its present form somewhere in eastern Russia, although it may have come from Africa at an earlier period in the world's pre-history. It is one of the three principal races of Europe, the other two being the Mediterranean and the Alpine. The former came into Europe from the south—*i. e.*, Africa—and is represented mainly by the Latin races; in appearance it differs from the Nordic mainly in being shorter and darker. The Alpine race is made up of a flood of round-headed,

long-bearded invaders who came from middle Asia, bringing copper implements and spreading over the Balkans and the near east until they pushed a wedge clear across Europe to the Atlantic.

THE AVERAGE SOLDIER

This painting was made for the Army Medical Museum some years ago, to illustrate the typical American infantryman. The height, weight and chest measurements were supplied from the statistics of the Surgeon-General's office. The model was a young Irish regular, whose head-form and dark hair and eyes are hardly typical of the American Army. (Fig. 1.)

The United States is perhaps more preponderantly Nordic in population which is liable to draft than any other country actively engaged in the great war, with the possible exception of Great Britain. It was in origin a Nordic colony, and more than 50% of its residents are today native whites of native parentage, almost 25% are native whites of foreign or mixed parentage, while but 14.5% are foreign born whites. The remaining 11.1% include 10.7% negroes, and .4% Indians, Chinese, Japanese, and all others.

Thus the native whites, who are distinctly and almost wholly Nordic, comprise a little more than one-half of the entire population, while in the other half, the Nordic stock certainly still holds the majority, as will be later shown, so that more than three-quarters of the total population is of Nordic descent. Furthermore, the Nordic stock consists almost entirely of citizens who will hence have to bear the brunt of the war, while many of the Alpine and Mediterranean immigrants have not become naturalized.

A DEFECT OF THE DRAFT

The allotment of draft quotas without exclusion of aliens was, from the eugenic point of view, a serious mistake in the draft. The result was that in many of the New England communities, where the proportion of aliens is large, an overwhelmingly large burden was thrown on the old American population. Captain Eben Putnam writes that in some communities it was impossible to fill the quota even when every native in the district was summoned. It would have been better to base the draft quotas on the population after aliens were excluded. While the old Nordics of the United States are willing to bear their full share of the burden of the war, and in fact will bear vastly more than their share without a protest, it seems more statesmanlike to distribute the burden as far as possible.

The Nordic always has shown the most marked pugnacity. The famous warriors of Sumer and Accad were evidently long-headed, tall and fair-haired. Achilles and Hector are supposed to have been Nordics. The Goths and Gauls that poured down over the Alps and literally wiped the Roman Empire off the map were of the same peace-disturbing race.

In Europe at the present time, a much larger proportion of the fighting men belong to the Nordic race than is generally supposed. Of course, the Scandinavian peninsula, where the Nordic is found in the greatest purity at the present day, has up to this time kept out of the conflict, but Nordics are to be found extensively in the fighting forces of most of the nations at war. Practically all the men from the northeast of Great Britain are pure Nordics, while the rest of the population is predominantly of Nordic blood, mixed with Mediterranean blood in the southwest. North of Paris France is largely Nordic, with the central region populated by Alpines, and the southern border by Mediterranean stock. In Belgium, the division is made between the Nordic Flemings and the Alpine Walloons.

The Central Allies depend no less on a strong fighting force of Nordic extraction. Germany is Nordic along the northern plains from whence come the Prussian militarists, and Alpine along the southern uplands. Austria is preponderantly Nordic, although Cevanolia and Anatolia are populated by a large percentage of brachycephs who are probably of Alpine origin. Hungary is peopled largely by pugnacious Magyars, who are nearly all dark, short and brachycephalic, and are mainly of Alpine blood.

In Russia, the Letto-Lithunians are entirely Nordic, and form a large part of the superior fighters, while the Poles, White Russians and Little Russians are Alpine. The Cossacks are now mostly Alpine in stock. Through the Balkans, the population is prevalently Slav and consequently Alpine. In Greece, the race was formerly composed of Mediteranean stock led by Nordics, but this has been almost entirely overlaid by a people of Alpine extraction.

The Mediterraneans are found in their greatest purity in Spain and southern Italy. In the north of Italy the Alpines form the majority of the population.

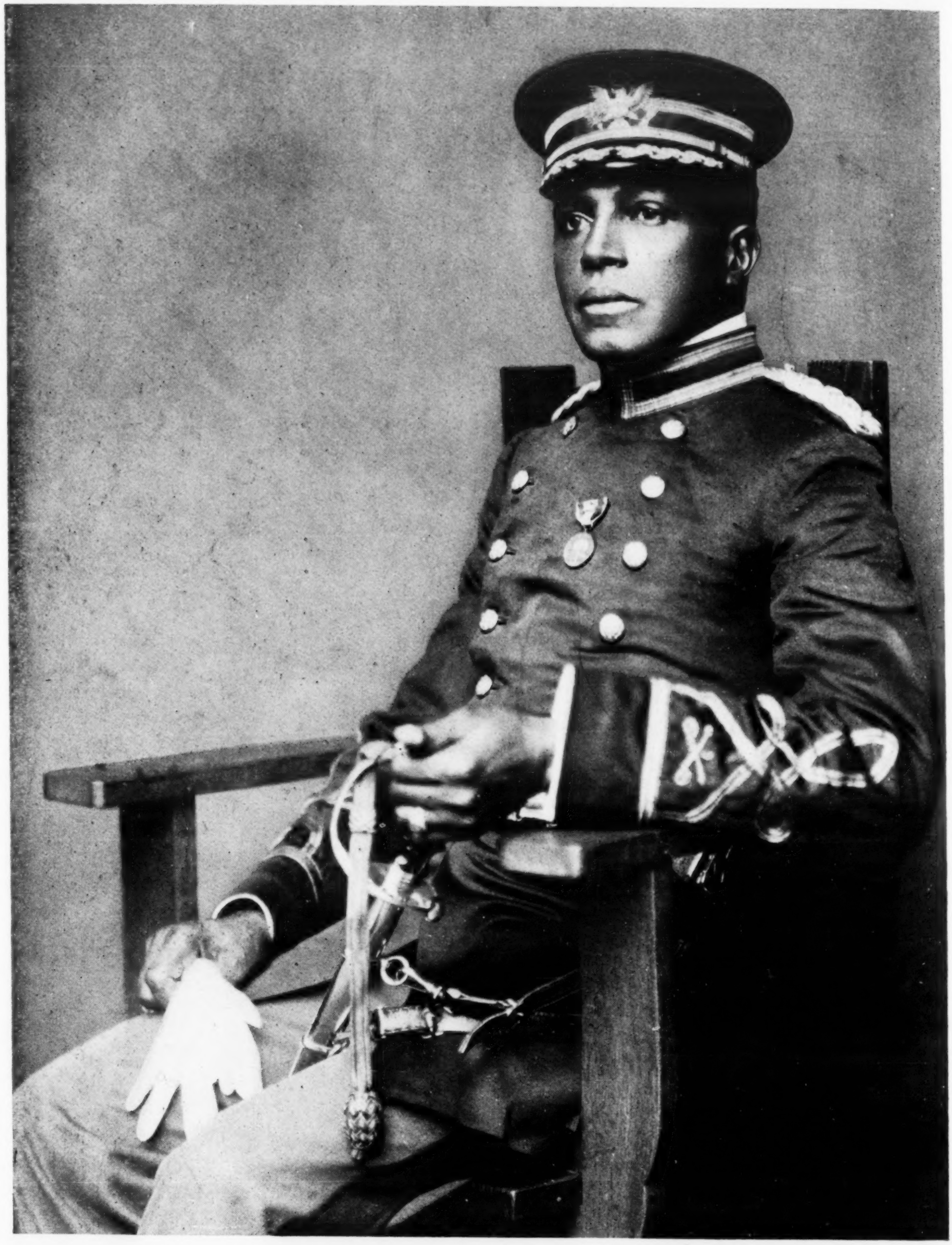
While these races have blended to a certain extent in almost every country, yet they are still distinguishable. But, it may be asked, can any real differences in fighting ability be shown among them?

It seems reasonable to believe that there can; that fighting ability is in part an inherent trait, of which one race may have more than another. This is strongly suggested by a study of wild animals, in whom wildness and pugnacity are certainly germinal qualities, and not merely the result of training.

At the same time, ability in modern warfare is not wholly a matter of pugnacity. It requires likewise coherence, obedience, and a great mass of traits of mixed germinal and social nature. Two nations may be equal fighters for very different reasons: one excels in dash, as the French, another in tenacity and persistence, as the English. This complexity of the qualities that make up a fighting nation may again be paralleled in animals. The fighting dog is a specialized breed which is constantly selected for two very distinct, inherent qualities—the ability to take punishment and the ability to give punishment. The former quality, gameness, is the more common, and it is not difficult to get a dog which will allow itself to be chewed to death without a whimper and which will start back into the combat after every round of battle, until he falls from exhaustion and loss of blood; and which nevertheless can inflict little damage on his opponent. On the other hand, some dogs are born with what the connoisseur calls a "long, firm, even bite" but they are "forty-minute dogs"—after a little fighting they get discouraged and quit. It is the rare combination of the two qualities that makes the unconquerable champion who gets his picture in the *Police Gazette*.

In a similar way, it is certain that races differ in their inborn fighting ability, as well as in their training, morale, and other acquired traits. The directors of modern armies should take this fact into consideration.

At present there are available six distinct stocks in the United States,



THE NEGRO OFFICER OF HIGHEST RANK

Only three Negroes have ever graduated from West Point, and only one of them is now in the Army. He is Major Charles B. Young of the Tenth Cavalry. Major Young, who is now 55 years old, entered the military academy in 1884 and has served in various cavalry and infantry regiments. He reached his present rank in 1912. In general Negro regiments in the United States have been officered by whites, but in the Spanish-American war a number of volunteer Negro officers were commissioned, and after the war two Negro regiments, the 48th and 49th U. S. Infantry, were enlisted for service in the Philippines, captains and lieutenants being Negroes. At the present time a considerable number of Negro officers as well as enlisted men are being trained. Photograph from *The Crisis*. (Fig. 2.)

each one of which should be able to play some part in the great war. These six stocks are the Indian, the Negro, the Jew,[1] the Alpine, the Mediterranean and the Nordic. Each of these stocks is distinctly different from the others both in temperament and physique. A careful consideration of this fact would insure the utilization of every stock where it would be of the most value.

From the standpoint of either fighting men or agriculturists, the American Indian will probably never be very effective. Pure blooded Indians are now extremely rare. Officially there are 265,000 Indians in the United States at the present time, but of that number it is said that less than 100,000 have enough native blood in them to be called true Indians, while many have little or no Indian blood, although classed for various reasons with some Indian tribe.

As a member of a large unit of his own race, the Indian would be of little value, due to his temperamental peculiarities. In the early nineties 3,000 Indians were enlisted as regular soldiers, but the attempt proved a flat failure, and the Indians finally had to be released.

But in spite of the disappointing result in that case, the Indian has often been invaluable for work which is suited to his mental makeup, such as reconnoitering, scouting, or the making of a sudden foray. Under such conditions he is brave enough, but he is not amenable to discipline and the terrible trench warfare would soon wear him out, while tuberculosis would decimate this exceptionally susceptible race.

There were many Indians with Pershing's troops on the Mexican border, and they distinguished themselves there in numerous ways. Although entirely unmindful of subordination they proved themselves invaluable if allowed to do their work in their own way, and were used only for scouting purposes. It seems probable that they could be made use of in the present crisis, guarding the Mexican border, and thus releasing men more competent for work in Europe. Thus, they would not be taken far away from their homes, and could be returned there at any time necessary.

VALUE OF NEGRO TROOPS

Negro soldiers have distinguished themselves on several occasions, and those that secure places in the ranks nearly always prove satisfactory. There were 178,975 Negroes in the Civil War on both sides, and although they were not extensively in action, they performed very creditably. Along the Mexican border, the work of the colored troops is well known, and their famous rescue of the Rough Riders at San Juan Hill is another example of their gallant bravery.

Heretofore Negro troops have been officered almost entirely by whites, but a training camp has been established at Fort Des Moines where subaltern commissions will be given to the best of the 1,200 Negroes who are now in training. The deportment of the men at the camp has been admirable, and has drawn favorable comment from many sources. There may be some difficulty in locating training quarters for the Negro troops where there will be no danger of conflict with the whites of the vicinity.

Enrollment of a large force of Negro soldiers is made difficult by the physical defects of the Negro race. Prominent among these is tuberculosis, a white man's disease to which the Negro is particularly susceptible here, out of his element and in what is biologically a white man's country.

A still more serious problem from a eugenist's point of view is presented by syphilis, which was made ground for exclusion from the National Army. It cannot yet be told with certainty just what effect this provision will have. A member of this association writes from Georgia:

"I am a member of the Board of Examiners here, and have been impressed with the greater number of rejections among the Negroes, and especially for syphilis and heart disease. Of course we physicians know how prevalent syphilis is among them, but I was not prepared to expect so

[1] Historically, the Jew is a blend of Mediterranean and Alpine.

many rejections for heart disease." This defect may, of course, be a result of syphilis.

NEGRO COMMISSIONED OFFICER.

Heretofore, Negro troops have been officered almost entirely by whites, but a training camp is now established at Des Moines, where 1,200 picked Negroes are being tried out, the best of them to get subaltern commissions. Dr. Joseph H. Ward, pictured above, is typical of the new régime. If the Des Moines camp is a success, the lower commissions in all the Negro regiments should be filled by colored officers. (Fig. 3.)

From Alabama a member of the association reports that "about 22% of the Negroes had been rejected" in one section of a large city, "while over 30% of the whites had failed to pass the physical examination. Local doctors tell me that no exemptions are made either for syphilis or gonorrhea unless the disease has progressed to a point causing other physical defects rendering the person unfit for service."

Another member, in Mississippi, says: "There has been no greater proportion of rejections of Negroes than of whites for any physical disability or disease except in the case of tuberculosis. I would say further that I do not believe great weight could be given to any figures obtained relating to the rejections because there is a certain tendency at least among southern physicians to discount a Negro's complaints and it is difficult to recognize such a disease as syphilis in any except the early stages."

AMOUNT OF INFECTION

The most reliable figures available are those of Major Vedder of the Surgeon General's Office[2] whose extensive application of the Wassermann test to applicants for enlistment convinced him that 50% of the Negroes of this age and class were syphilitic, as compared with 20% of the whites. If the more stringent examination given at the cantonments leads to the exclusion of all syphilitics, it will have two very serious results: (1) it will exclude many white soldiers who, if cured, would be of much value; and (2) it will exclude a much larger number of black soldiers. Not only are these Negro soldiers needed, but their exclusion means in many cases that additional Nordics must be called up to take their places, thus throwing an unduly heavy burden on the old American stock, and crippling the nation by drawing away men who are needed at home to perpetuate the industrial machinery which is as important in modern war as is the army.

If all syphilitics who are not otherwise unfit for service are enrolled in separate battalions, cured, and then called to the colors, the country will gain immensely. If the announced intention of the War Department absolutely to exclude syphilitics is really carried out, it may well be held in the

[2] *Therapeutic Gazette*, May 15, 1917.

future to be one of the great mistakes connected with the conduct of the war in America.

Negroes from the French colonies and Sikhs and Gurkhas from British India have been used to some extent in Europe, but although they proved courageous fighters in attack, they did not take kindly to remaining in the trench to be shot. The small Gurkha had a knack of leaving his trench, and worming his way to the German line, where he would tap on the ground with his big knife. When the German whose attention was attracted by the noise would peer up over the edge to investigate, the Gurkha would neatly sever his head. Such fighting appealed to the Orientals, but proved too dangerous for the modern type of warfare, and most if not all of the Gurkhas have been sent back to India.

THE JEW AS A FIGHTER

Although his race is numerically small and commonly characterized as peace-loving, the Jew seems to demand special attention. While forming but 2% of the total population, the Jewish race contributed more than 6% to the various military organizations of the United States in 1915. About 4,000 Jews fought in the Spanish War. At present Rear-Admiral Strauss, a member of that race, heads the Naval Bureau of Ordnance. The Jews do not seem to furnish as many officers as do other races, but in the rank and file their work has been excellent. Many officers who bear German or American names are of Jewish extraction, although they may have become so thoroughly assimilated as to have changed their names. There are more than 2,000,000 Jews in the United States.

But a vast majority of the soldiers will be of distinctly Nordic stock. The Nordics, upon whom the stability of the American nation has ever rested, are those who will be killed in largest numbers. This inevitable result of the war cannot but have a far-reaching effect on the nation as a whole. A vast number of men who are superior, both physically and mentally, will be killed or severely wounded, and many thousands will come back crippled by disease, or will have passed the age when they are likely to marry, or will have developed nomadic traits formerly inhibited, and for one of these reasons will never reproduce. Many of those who fight in the trenches will never pass on to offspring those superior attributes which have made their possessors the pride of a nation.

The European war has shown that all races fight well if properly led. The European armies are undoubtedly led by Nordics to a much greater extent than is popularly supposed, and America's armies certainly will be almost entirely officered by Nordic stock. It is not wise to let the losses of the war fall too heavily on any one stock of the nation, but as things now stand, the Nordic will bear most of the loss, because he is physically fit, generally has fewer dependents, and because the Negroes and aliens will, for various reasons, be frequently eliminated from the draft. It would hence be wise to take special pains to see that each stock contributed its quota. There seems to be a good chance of using the aliens in some line, and except for the exemption of syphilitics, there seems to be no reason why the Negro should not eventually take his part of the burden. There are lots of good fighters in the United States, and a place for each of them. Let each be in his place.

Increase in Divorces Follows War Marriages

Eugenists have pointed out that an increased number of hasty and ill-considered marriages constitute one of the dysgenic features of war. Sexual selection in such cases is not as good as if it were more deliberate. This contention seems to be borne out by the fact, mentioned in London correspondence of the Associated Press, that there is a large increase in the number of divorce cases now filed in that city. Many of these divorces are recognized, the dispatch says, as being the outcome of hasty war marriages.

PSYCHOLOGY AND THE WAR

Emergency Stimulates Practical Work and Application of Science Rather Than Development of Theory—New Views of War—Probable Changes in American Institutions—Need for More Research on Man's Inherent Traits[1]

G. STANLEY HALL
President, Clark University, Worcester, Mass.

RASH as it may seem to draw any lesson as yet from the present war, in which the great Nordic race which embraces the dominant elements in all the belligerent nations is committing suicide, the following points, which can be only hinted at in my twenty minutes, seem to me worthy of consideration here.

Mr. Hafner, through whom most of us receive our foreign periodicals, writes, "About one thousand French and German scientific publications have suspended as a result of the war, and about half of those that remain have been issued less frequently or in reduced size." They have also suffered in quality because so many collaborators doing the best work have been sent to the front, and many of them wounded or killed. About all the research being now carried on is in the medical field and in hospitals. Since April last, practically all continental publications have been kept out of this country. This affects not only our journal clubs but cuts off from us the stimulus of European thought, so that we are now the only great country in the world where research can go on as before.

Last month I asked and obtained the responses of representative authorities of all the twenty-four universities in the American Association concerning this situation. The responses were very diverse. One prominent university president amplified the view that it was high time and would do good for America to be weaned from its European alma mater. Another held that the cessation of importation of intellectual goods made in Europe would cause the culture level not only in academic departments but throughout the world to sink to a lower level. Most, however, held that this shortage will be a new and serious responsibility upon American scholars to make it good, that the present situation is a loud, clear call to independence, an opportunity for new leadership, that it should result in higher standards of originality and increased output of investigation, that the war opens opportunities to American universities as great as it has afforded to certain industries here, and that we should emulate the latter in devising new methods and in vastly enhancing output. If we only have the vision, the war will bring here a great advance in culture. The new Research Council of the National Academy and the Committee of One Hundred, with their splendid if, as yet, unrealized program, indicate that we are at least making a feeble beginning to respond to the situation. A vast deal has been said and written about research here within the last eighteen months, and there is every prospect that it will have at least enough, let us hope not too much, organization.

AMERICAN PSYCHOLOGISTS LEAD

As for psychology, whether we regard the quality or quantity of work done here in every field, all the way from introspection to behaviorism, including the study of animals, children, normal and subnormal, anthropology, especially as represented by our Bureau of Ethnology, the work in tests, scales, in stand-

[1] This address was prepared for the twenty-fifth anniversary of the American Psychological Association, New York, December, 1916, and is reprinted from the first issue of Dr. Hall's interesting publication, the *Journal of Applied Psychology* (March, 1917).

ards, and, indeed in about every domain of psychology (unless we except psychiatry, where most work worth while that has been done has been inspired either by Kraepelin or more lately by Freud), I believe we are quite ready to meet this call in the field of both pure and applied psychology, provided only we escape the obsession of finality in either method or result and realize that psychology is just beginning, the best things are yet to be found out, and that its difficulties and obscurities are the twilight of dawn and not that of evening.

2. Another effect of the war upon psychology that now seems probable is to lay stress upon applied as distinct from pure aspects of research. For two and a half years, practically all the leaders in most of the physical sciences, particularly physics and chemistry, have ceased to advance their science as such and have been absorbed in making it immediately serviceable; while even in the most humanistic fields culture has yielded to *Kultur*. The criterion of values in science is now what it can do pragmatically, in the Vaihinger sense. Talent of the order of Edison or Burbank has taken precedence over that of men like Helmholtz and Weismann, and the work of the latter is transvalued by the test of utility. The war has given the world its greatest lesson in scientific efficiency. Just as Russia in the war with Japan did not begin to realize how far the latter country had moulted all its pre-Meiji, and indeed all liberal culture, and focussed its entire energy upon practical efficiency, so none of the Entente Allies, least of all England, realized how far Germany had gone in casting off the culture of half a century ago, and in almost a single generation acquiring a new soul that made it, instead of the least, the most hard-headed, practically effective nation the world has ever seen, with hardly a vestige of the old, speculative, sentimental traits of the days before 1870. As pure chemistry failed to appreciate the value of the formula for making nitrate, which Germany had secretly bought from its Norse discoverer, and which enabled it to produce 300,000 tons of ammunitions during the first year of the war, at one-third its cost to the Allies, so its tests of the senses, motility, fatigue; its establishment of distinct digestive, respiratory, muscular, and nervous types; its temibility tests, which eliminate from the ranks both on donning the uniform and after every wound, thereby greatly reducing liabilities to panic; the French tests and assignment of men to infantry, cavalry, artillery, aviation corps, etc., according to the standard types of McAuliffe, Segaud, Thooris and Sorel, have shown how immediately serviceable psychology could be made in a new field. Already enough of the carefully guarded military secrets of these tests for specific lines of military service have leaked out to suggest why the German and French armies are so much more effectively organized than the English and Russian, and to show that applied psychology can render the most valuable service. We see with mingled admiration and dismay to what lengths Germany will go in applying all the latest knowledge in every field, not only in industry, but municipal and social organization, and even in eugenics, in ways often far beyond the reaches of the old morality.

THE STUDY OF HUMAN NATURE

Corporation schools, which here in the last four years have come to represent the advanced line of vocational discrimination and guidance, have already demanded of psychology vastly more knowledge of character and its traits than it has yet attained; and this has led, as we all know, to very many tables of human qualities, that are, some more, some less scientific, and premature, so that we can only very imperfectly and tentatively answer all the questions that business is now putting to us. So the war has still more urgently called upon psychology to do things it was not ready for, which had to be done extemporarily and as best they could by intuition. In both fields the call is so loud and insistent that it seems to me every psychologist should be able to give some reason if he does not do what in him lies to a better knowledge of man and life under

modern conditions, even if he has to break in some degree from his own lines of work, in order to help in the supreme problem of diagnosing each individual, and steering him toward his fittest place, which is really the culminating problem of efficiency, because human capacities are after all the chief national resources. In conning only a few of the some three thousand books and pamphlets on the war our library has made a specialty of collecting, only one topic has impressed me more than the literature that enumerates the various things which psychology is doing or can do, not only for war itself, but for the new social and industrial order which characterizes the state of a nation in war. Must we not, therefore, infer that such facts as these suggest that we readjust the old differentiation between pure and applied psychology, and realize that research in the latter field may be just as scientific as in any other, and that the immediate utility of our results is at least no longer a brand of scientific inferiority?

3. We shall surely have a new and larger psychology of war. The older literature on it is already more or less obsolete from almost every point of view, and James' theory of a moral, and Cannon's of a physiological, equivalent of war seem now pallid and academic. More in point are the reversionary conceptions of Freund, Pfister and Patrick, that it is more or less normal for man at times to plunge back and down the evolutionary ladder, and to immerse himself in rank, primitive emotions and to break away from the complex conventions and routine of civilized life and revert to that of the troglodytes in the trenches, and to face the chance of instant death when the struggle for survival is at its maximum in the bayonet charge. Lahy, Crile and perhaps a score of others described, on the basis of much observation and insight, the stages of this recessional. First is the general perturbation at home when mobilization is decreed, the fraternization of all classes, normally more or less aloof; the rank credulities and superstitions that suddenly arise and spread by psychic contagion, often to the clearest heads and coolest hearts, on the basis of high expectant tension; the mad rumors, fears, suggestions, often so painfully acute that the call to arms is a relief.

A NEW LIFE

Second comes the parting from home and loved ones; the donning of the uniform and with it the *esprit de corps* of the Army; the intense activity of the training camp; the remarkable development of powers of effort and of endurance, which makes each often a marvel to himself, a power by which those from sedentary life often excel laborers and peasants; the games, songs, theatricals, often camp newspapers, in which phenomena we see instinct seeking to compensate, in Adler's sense, for a deeper but repressed anxiety. Life at this stage is so absorbing that the old life at home pales, and loved ones are thought of with surprising infrequency, and it becomes harder to write to them; the sudden setting up, physical and often moral, of flabby individuals, to sleeplessness, heat, cold and hunger, as the individual learns to draw upon his phyletic reserve, and is often surprised to find the largest drafts upon it honored.

Third, in the advance into the trenches, where silence and immobility are often necessary under the greatest excitement, breaking down many a nervous system, and when everything else, past and future, is forgotten in the struggle for present safety and physical comfort, the long confinement and constrained positions interspersed with digging, bailing water, with sometimes personal draftings to carry despatches or rescue wounded friends from the "hell-strip" between the most advanced opposing lines, the acute attention to the sound of projectiles and their explosion, it is no wonder that some grow mad and rush wildly at the enemy and to certain death, or else back to safety, while those with stronger nerves develop with amazing suddenness a callousness to danger, fatigue, hunger, discomforts, while we sometimes have the unique reaction of

sudden fraternization with the enemy which Kreisler has so well described.

Fourth, when the charge is called, some drop, fatigued and perhaps dead from exhaustion, while others who thought themselves spent marvel at the sudden development of utterly unexpected resources in their own systems. Here each faces his man intent only upon killing him and escaping from being killed himself. When this is all over the survivors frequently, and sometimes for days and weeks, live in an illusion that the charge is still on, and they cut, slash, stab imaginary enemies, while the same obsessions haunt their sleep, so that even the hospitals, a few days after the battle, are noisy with the imagined battle which still rages in the soul. Those who have once had this experience, too, we are told, should recover within the hearing of the big guns, lest these obsessions undermine their courage and make them cowards and panic-starters despite their will. Only very slowly do even the sanest come back to full realization of what and where they are, what doing, and only gradually do their friends, relatives and home conditions live again in their souls as the past validates itself in the all-absorbing present.

THE STRAIN OF WAR

Such, too, is the unprecedented strain of the present war, with its high explosives, the contractions of both time and space, poisoned gases, the fatigue and demoralization deliberately planned by each enemy by continuous day and night bombardment before the infantry advance, that it is no wonder that each belligerent has had to develop a new type of hospital for cases of shock due to these causes. All agree that the nervous system of the belligerents has never been subjected to such a strain, and many hold that this of itself will impair the quality of parenthood perhaps for generations. War is a grim and awful experiment upon human nature, but like vivisection, disease and insanity, it should be studied intensively to find its nature, cause, and, if possible, its cure and at least its function for the individual and society. The very voluminous data in this field now fairly cry out for more and better interpretation. Raw instinct, feeling and emotion, which are the very roots of human nature, are stripped bare of all their disguises. The motivation of war, however interpreted, is psychological, whether its cause be individual, social, economic, or religious. War is still regarded too much as panics and pestilences were before science explained and controlled them. Hence it is that we should welcome the suggestion lately made of a society planned, to be given an international organization, to study the psychological aspects of this war, selecting literature, making special observations, according to prescribed methods, synthetizing results from all fields, in order that in the end we may have some definite conception of what war really is, does and means. At least the vastness and abundance of the data should not cause them to be neglected, seem common or go to waste.

4. Will the war tend to increase collectivism at the expense of individual activity and initiative? It stands forth already as the most perfect example the world has ever seen of completely organized teamwork. The individual is only a cog in a vast machine. The subaltern and even the lower officer knows almost nothing, and indeed one high authority has told us that only three men in one of the leading belligerent countries know anything in regard to the general military plan; and very few attempt to understand what is going on in other parts of the line in any front. The rest obey literally, trusting in the wisdom at the top. They do much and perhaps have to face almost certain death in an enterprise that seems to them utter folly, and they have no consolation save their faith that the leaders know it to be for the good of the whole. This is necessary for all effective armies, but in citizens of an autocratic government it comes easier and is more complete than in those pervaded by the spirit of democracy.

This, of course, is one of the reasons why wars always favor autocratic, and are unfavorable to democratic, institu-

tions. This concentration of power often includes the civic community, commandeered, while personal liberty suffers from countless encroachments. So mechanized is war today that there is ever less opportunity for brilliant coups, acts of self-initiated heroism and daring. So, too, the *esprit de corps* of the Army is strong and rigid in enforcing its collective judgment and sentiment, while, if internationalism declines, patriotic and perhaps fanatical nationalism is incalculably strengthened. Thus it is no wonder that when soldiers are at last discharged and go back to civil and industrial life, they find it hard to readjust. They have lost positions to others who have gained while they have declined in aptness for their old jobs. Instead of the closer tie of companionship in arms there remains only that of fellow-citizens. They have grown used to taking orders, to being fed, clothed, cared for, and so find it hard to return to doing these things for themselves, and expect government consideration in the form of pensions, offices and other favors. They lean on the state that they have served, instead of learning to exercise their own individual powers. In all these ways war is unfavorable to the spirit of democracy and more favorable to monarchical tendencies. A few new and powerful leaders arise because a few men have learned to exercise command, while the masses have learned to obey. War is as necessary for monarchy as peace is for democracy. One over-emphasizes order, system, control; the other magnifies beyond bounds unrestrained personal liberty. Here is the issue of the present struggle. Germany never had a revolution such as in England and in France swept away the spirit and even the vestiges of feudalism, which Teutonic genius has conserved and transformed into something which at least the neutral world must admire. The least governed people can perhaps best understand the most governed, and yet here our psychology fails to recognize the fact that it is prepersonalities that have made history, and that it is their synthetic organization, one with another, that has created civilization and culture, and that if these elements or units in the body politic, social and industrial, have their freedom repressed according to any wisdom the wit of man has yet devised, the whole of which they are members is sure, sooner or later, to lose the all-originating power of free and progressive development. Despite the penalties of freedom, such as license, sometimes degenerating to vice and crime, despite disorder, crude, often unsuccessfully and at best oft-repeated trial and error methods, if we believe in man and in a future that is to be greater than the present, we must believe that the American way will lead mankind to an ever higher goal of evolution and emancipation from the countless repressions that dwarf and stunt him in the home, the school, church, industry and state. The German superman is for the people an irridescent dream evolved in order to compensate for the fact of over-institutionalized life, and even the superstate there is the state that now is, while our superman and state is that which is to be when freedom has done its perfect work.

NEED FOR STUDY OF MAN

Finally, in view of all this, should we not in this country, along with all our other psychologizing, foster as something especially germane to the spirit of our institutions the study of individualities and racial and all the other very diversified groups which constitute our heterogeneous population, and do so not only for the development of anthropological science, but with the ideal of fitting each one's aptitudes of body, health, native gifts, traits of character, experiences and motor patterns, to just that occupation that best fits his own psychophysic organism, striving to guide each to that environment, industrial, social or cultural, in which his personality will find most incitement to unfold freely? Should not one of our ideals be to give each the kind and degree of self-knowledge that will make not only for maximal self-reverence and self-control, but for maximal freedom and the most efficient life? If a democracy achieves greatness

it must be not by the method of regimentation or any kind of organization imposed from without, but by finding the place in life for which each is best fitted. Must we not study individuals more than we study vocations, and thus perhaps some day may not the very apex of democratic society be found in its psychology, charged with the responsibility of seeing to it that the best powers of every man are discovered, developed, and put to their highest use?

Women's Separate Colleges Are Losing Ground

As the marriage rate of graduates of women's separate colleges is uniformly very low, it is interesting to the eugenist to note that colleges of this type are not holding their own, of recent years. "Fortunately," says Roswell H. Johnson ("School and Society," 1917, p. 679), "the percentage of women attending coeducational colleges is growing very rapidly. From 1895 to 1902 the number of students in separate colleges for women increased from 14,049 to 15,544, while the attendance of women in coeducational colleges increased from 13,940 to 23,216. If we exclude Roman Catholic colleges, the percentage of coeducational colleges grew from 30% in 1870 to 72% in 1902. These figures may be in part owing to the attitude indicated by graduates of separate colleges whom I have heard deplore the separateness."

Money Not Enough to Save Child Lives

The payment of maternity insurance or benefits has often been mentioned as an effective way of decreasing infant mortality. Such payments are now made in Great Britain but the London *New Statesman*, reviewing recent statistical reports, says that while they have made the price of midwifery go up, they have not had any effect on the infant mortality. This has, indeed, decreased during the war, but it is declared that no connection appears between infant deaths and the payment to poor mothers of sufficient money to meet the expenses of confinement. The *New Statesman* thinks the infant mortality is most closely related to overcrowding. It is quite likely, however, that this is merely symptomatic, and that the fundamental cause of the infant mortality is in a majority of cases inherited weakness.

A Decrease in American Intelligence

Possibility of a slow fall in the average intelligence of American towns appears from a study made by Prof. Rudolf Pintner ("School and Society," 1917, p. 597). He reports on a survey made of a town in the middle west (presumably Ohio), with 913 inhabitants. There were 154 children in the grade schools and all of these were examined by means of mental tests. Only one very bright child was discovered; there were 94 with a mental index below 50 and 60 who were at 50 or above. The average mentality of American children of corresponding ages is 50. The median of all the children tested was 40, an indication that they are below the average. It is significant that the American population of the town was found to be steadily decreasing, through race-suicide, while the brighter high school graduates usually leave town in search of greater opportunities. The town, therefore, deteriorates each year, in the average of intelligence—a deterioration which many eugenists think would be shown, in a less degree, could the necessary measurements be made of the mentality of the nation's entire population.

THE BLIND CAVE FISH

A Classical Problem of Evolution—Many Theories to Account for Its Loss of Eyesight—Cave-Darkness Probably Allows Unfavorable Variations to Survive—Life Habits of the Fish

OF ALL the strange creatures that live in subterranean waters, none is more familiar than the blind fish.[1] Fig. 4 shows one of the most commonly known, and perhaps the most interesting, of the blind fishes, that inhabit the Mammoth Cave of Kentucky.

This fish (*Amblyopsis spelaeus*) attains a length of 5 or 6 inches when adult, and varies in color through several shades of light pink and white. In general shape, it resembles a minnow of equal size. Such a comparison holds true only for general appearance, however, as upon closer inspection a multitude of adaptations are to be seen.

The eyes in most specimens have entirely disappeared, so far as can be seen by external examination, although in many instances dark spots may be detected where the eyes ought to be. The structure of the vestigial eye differs greatly in different individuals, but a microscopic examination will always reveal some traces of the organ. In some specimens, an external eye is found, presumably a throw-back to the original condition.

It has generally been stated that Amblyopsis brings forth its young alive, but it now appears that such statements are based on ignorance. The eggs issue from the oviduct and lodge within the gill cavities of the female. It is probable that they are fertilized in that situation, as unfertilized eggs are often found there. The young fish are also guarded in the cavities for some time. If the eggs do not hatch, they remain in the gill cavity until they disintegrate.

The young are blind when hatched, and presumably when in an embryonic stage as well, and remain so throughout the duration of their life, irrespective of their surroundings. Various experimenters have taken very young fish or even eggs, and raised them in bright light, but in every case the environment has proved to have little or nothing to do with any development of the eye.

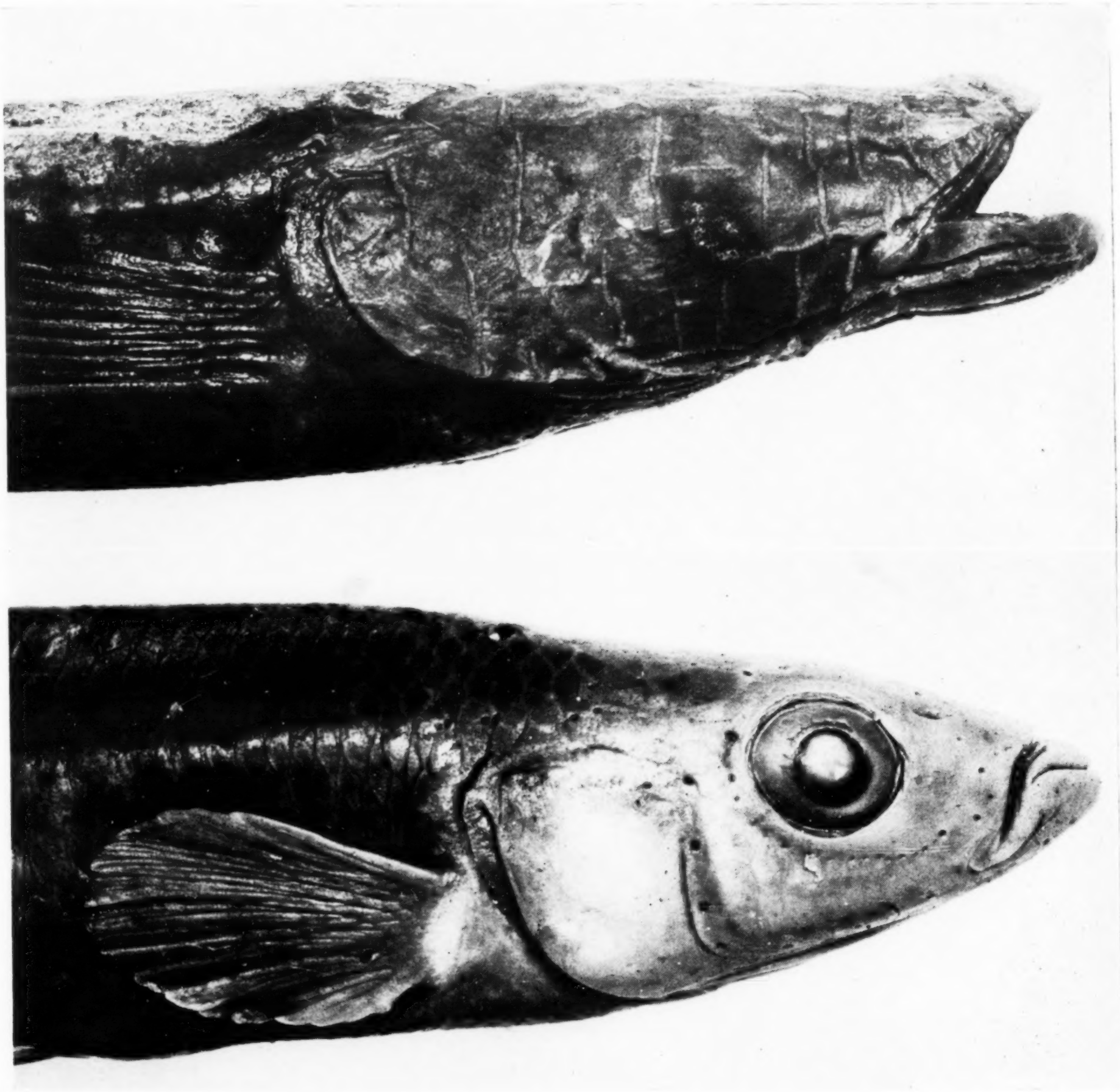
Amblyopsis spelaeus is found in various localities in Kentucky, Indiana, Michigan and Ohio, nearly always in pools in the limestone caves of those States, but is occasionally found in deep wells, and even in open water, where it is possible it may have been brought accidentally. It probably lives to a large extent on small organisms which may be invisible to the eye, but it also eats small arthropods when such are procurable, and in captivity will even eat small pieces of meat.

DEPENDS ON SENSE OF TOUCH

Since the fish is entirely devoid of sight, it must necessarily depend upon other senses for securing food, and probably the most important of these is the sense of touch. Tactile papillae, which are akin to the antennae of insects, but are generally like small ridges in the skin, are located profusely on various parts of the body, especially around the mouth and head and on the ventral fins. If, when swimming close to the bottom, the fish touches some substance with its ventral fins, it will nearly always stop and investigate. It seems that it is unable to detect whether the substance is edible or not by the fins, but the papillae around the head are so developed that they can tell the difference between edible and non-edible substances.

It has been stated that the "hearing" of this fish is remarkably acute, but here again it appears that this acuteness

[1] The most detailed account of cave fish is that of Carl H. Eigenmann (Cave Vertebrates of of America. *Carnegie Institution of Washington Publication* No. 104, 1909).



BLIND CAVE-FISH AND ITS NORMAL RELATIVE

Above is a fish from the Mammoth Cave of Kentucky, which has no eyes but merely a slight discoloration of the skin at the point where the eyes ought to be. To take the place of sight, the fish depends on the sense of touch even more than blind people do—it is said in this way to be able to determine whether a certain object with which it comes in contact is or is not edible. If a fish is going to live in cave-darkness, eyes would obviously be of little use to it; but the exact nature of the process by which the eyes disappeared has long been a bone of contention among students of evolution. Below is a minnow, probably distantly related to the blind cave-fish. It may, therefore, give some idea of what the cave-fish looked like before it lost its eyes and became modified in other ways to meet the conditions of life in underground waters. Photographs (much enlarged) by John Howard Paine. (Fig. 4.)

in detecting certain kinds of vibrations is due to the papillae. Experiments have proved that the ears are poorly developed, and the fish is unable to perceive most sounds, but the papillae are so sensitive that any slight disturbance of the water is instantly noted, and since the fish are confined almost entirely to pools, any such disturbance is sufficient to warn them that the vibrations are the result of something unusual. The fish is entirely scaleless, these papillae evidently replacing the scales. The ear itself is apparently normal, and while it is evidently not used to detect sound, it probably serves to maintain equilibrium.

The fish is believed to breathe through

the skin, but it apparently needs little oxygen, as one can keep a large number of them in a pail of water for some time without changing the water and they do not appear to suffer. When placed in an aquarium where there is a division into two parts, one light and one dark, the fish will always seek the dark. The optic lobes of the brain have degenerated greatly, but in other respects the brain shows little change. There are many other adaptions, but a sufficient number have been mentioned to indicate the changes which have taken place in this remarkable fish.

Fig. 4 also shows a member of the genus Fundulus, the killifishes, or minnows. There are more than a score of species in this genus, and the various groups include many different types, but this one is possibly distantly related to Amblyopsis and may give an indication of how the ancestor of Amblyopsis looked, and how the genus Amblyopsis might look today, if adaptive selection had not allowed the deformed members to establish the status of the species rather than the normal members. Such an evolution can be paralleled in some human societies where misfits are perpetuated and crowd out the normal population. A degenerate clan like the "Jukes" may thus take possession of a mountain valley and fix the tone of the whole population.

HOW EYESIGHT WAS LOST

The question of how the cave fish lost its eyes has long been one of the stock subjects for debate among students of evolution. Even to review the hypotheses that have been advanced would require a long article. They may, of course, be broadly divided in two groups: on the one side are the Lamarckians who think that the eye atrophied as the result of disuse and that the effects of this disuse were inherited, with cumulative results in each generation; on the other side are the Darwinians who look to some form of natural selection, acting on variation, to produce the observed result.

The natural method of deciding between the conflicting views would be by experiment, and a number of biologists have conducted experiments with such fish, but the results have in no case been conclusive, probably owing to the short time they covered, as compared with the long time in which the fish may have been undergoing evolution.

It is quite likely that various species have reached their eyeless condition in various ways, and that even on one species more than one cause has been operating to produce the absence of vision. There are at least two explanations which can be plausibly supported by modern knowledge of genetics.

1. It is possible that the blindness was produced rather suddenly as a result of hybridization, exposure to the action of chemicals, or some other powerful influence. Blindness can be experimentally produced in fish by these means. The fish once being blind, they wandered into a cave—or perhaps were in a cave when they became blind—and were able to survive because eyes were not of value in cave-darkness anyway. If they had stayed outside the cave they naturally would have perished. In this view the cave is not responsible for the blindness, either directly or indirectly; it merely preserves the fish who have become blind for some other reason. This is the explanation which has recently been advocated by Jacques Loeb,[2] among others.

2. The commoner explanation looks on the blindness as being of slower development, although not, as the Lamarckians supposed, produced by cave darkness. It is supposed that a number of normal fish got into a cave. Those with the best sight would find their way out; those with naturally defective vision would be unable to escape, and, remaining there, would perpetuate their kind. In the cave darkness acute vision would no longer be essential to survival. There being no predaceous enemies, the fish which could not see at all would have just as good a chance of surviving and leaving

[2] The Organism as a Whole, Chapter xii. New York, 1916.

offspring as would the one with fairly good sight. Now in all the fishes, it is supposed, variation of the eye is constantly taking place, and variations which tend to spoil it are much more frequent than those which tend to improve it, on the general principle that an accidental change is vastly more likely to harm a complicated mechanism than to add to its perfection. In the open these unfavorable variations are constantly being weeded out by natural selection; in the cave they are allowed to survive, and hence the whole population of cave fishes eventually comes to lack eyes, these organs having been deteriorated by unfavorable variations, generation after generation.

Both these explanations require to be supported in detail by numerous additional hypotheses, and they are not beyond criticism. They are, however, probably the most satisfactory that have been so far suggested.

Advice for Nervous People

THE MASTERY OF NERVOUSNESS, based upon the re-education of self. By Robert S. Carroll, M.D., Medical Director, Highland Hospital, Asheville, N. C. Pp. 346, price $2. New York: The Macmillan Co., 1917.

In the stress of modern life, almost every man and woman at some time faces the problem of nervous debility. To help them meet this problem, Dr. Carroll has written a simple, sensible, practical book. It is not at all technical, but is intended solely for the layman, dealing exhaustively with right methods of eating, working, playing, thinking; with the emotional and the intellectual life. It should be helpful to many.

Dr. Carroll's treatment of heredity is very casual and not particularly clear. He appears to think that a man may, by overeating and the use of tobacco as well as by other excesses, damage his germ-plasm in such a way that his offspring will be born with impaired nervous system. Proof of this would be received with much interest by geneticists. However, a discussion of heredity is not an integral part of the book, and it would not be fair to lay too much weight on its shortcomings in this direction.

A Study of Men of Genius

GENERAL TYPES OF SUPERIOR MEN, a philosophico-psychological study of genius, talent and philistinism in their bearings upon human society and its struggle for a better social order. By Osias L. Schwarz, with a preface by Jack London and an introductory letter by Max Nordau. Pp. 435, price $2.50 net. Boston: Richard G. Badger, 1916.

It is not often that a book carries, in its own introduction, so fair a review as Dr. Nordau has written to Dr. Schwarz. He says, in part:

"Your study on genius, pseudo-superior man and philistine is in reality a pretext for invective against the average man who is, in fact, an average beast. Your indictment against that type is wonderful in its quaintness, raciness and overwhelming power. It compares favorably with the very best, most scathing satires on the miserable creature man that I know of in the world of literature. But it is dogmatic, not scientific, it is subjective and cannot claim that calm objective argumentativeness that carries with it conviction even to obtuse or oppositionally oriented minds."

The present reviewer indorses Dr. Nordau's judgment but would add that he spoke too mildly when he wrote to Dr. Schwarz, "Your analysis of hereditary influences in the formation of genius is hazy." No one should expect to get any real anthropological data from the book. Nevertheless, it is stimulating, and any thoughtful reader will enjoy dipping into it.

SKUNK BREEDING

American Mammal Gaining Recognition as a Valuable Friend of the Farmer and a Producer of Desirable Fur—More Than 500 Skunk Farms Now in Operation—Several Mutations Found

HERETOFORE usually regarded as a noxious pest, a destroyer of birds and their eggs, as well as the agent of frequent depredations on the farmer's hen roost, the skunk is now being recognized as one of man's valuable allies, not only as a relentless destroyer of farm pests, but also because of his increasing value as a fur producer. His worth in the fur market is a recent development, but already more than five hundred people in various parts of the United States are engaged in breeding skunks, either selling the pelts to furriers or disposing of the live animals to others who seek to start fur farms.

More than a dozen States have already passed laws protecting the skunks and probably, as the unusual economic value of the animal becomes better understood, similar laws will be passed in every State, affording fuller protection to one of the farmer's best friends, and one of the most valuable of American fur bearers. The muskrat, mink and skunk are the only three fur-bearing animals which are still fairly abundant in the United States, and of these the mink is already in danger of extinction, due to the fact that it breeds but once a year and has been thinned out greatly by close trapping.

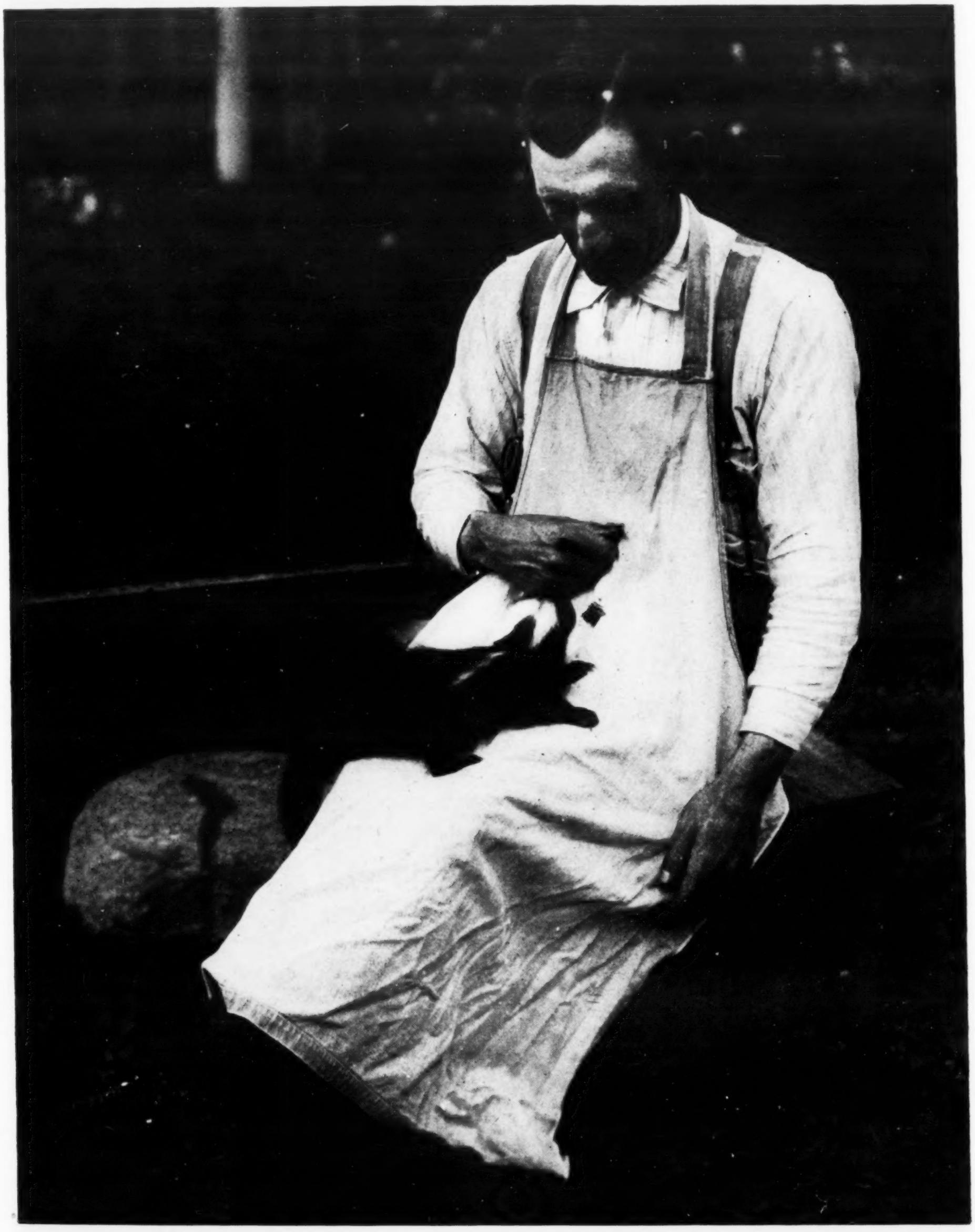
Skunks are divided into two general classes, the spotted and the striped, by those raising them for fur. Zoologically, many species, subspecies and races are named, but ince the breeders recognize two classes in their work and cross their animals freely without regard to scientific technicalities, the commercial classification will be sufficient for this note. The spotted skunk is generally too small for profitable fur breeding, and due to the peculiar coloration, its pelt is not so highly prized as that of the striped skunk. When the pelt of the spotted skunk is placed on the market, it is generally called "civet" and under this name it has enjoyed a decided vogue for the past few years. In spite of the popularity of "civet," however, the striped skunk is still the one most sought for commercial purposes, the value of the pelt depending on the amount of black it contains. A pure black pelt is worth about $10 on the present market, the color of the skins thence ranging through the intermediate splotchings to pure white. Ordinary skins are worth from $3 to $6 apiece when raw.

COLOR INHERITANCE

J. A. Detlefsen of the department of genetics, University of Illinois, has found a number of mutations which are valuable for their types of fur, and is breeding these and making a study of color inheritance in the skunk. It seems probable that skunk breeding will eventually be carried out in a much more scientific fashion than it is now, for some breeders state that already they have been able, by several generations of careful selection, to produce pure black animals which appear to breed true to type.

The most objectionable feature of the skunk as a pet has been its overpowering scent, with which every country-dweller is familiar. The scent is ejected from two oval sacs located beneath the skin just below the tail, which are covered with such powerful muscular tissue that a vigorous skunk has been known to eject the fluid as far as 15 feet, although 6 to 10 feet is a more common distance. It is often practically impossible to remove the odor, especially from the clothing, although gasoline is of value as a deodorant, while chloride of lime likewise works very effectually.

Most skunk breeders remove the scent glands when the skunk is quite young by a simple operation which is



THE SKUNK IS NOT NECESSARILY TO BE FEARED

It is an unpleasant neighbor when annoyed, but otherwise a desirable one. Few mammals are more valuable to the farmer in destroying vermin. In recent years, skunk fur has been much in demand, and more than 500 breeders in the United States are now raising the animals in captivity, while geneticists are working to produce superior color varieties. Photograph by Brown and Dawson. (Fig. 5.)

easily performed after a little practice. But one breeder has found this unnecessary and claims that with proper care no trouble need be met with from the scent. He finds that when skunks are raised in captivity and treated with kindness they no longer throw their scent. To prove the point, he is now raising skunks *au naturel*, and is shown in Fig. 5 handling them without the least apparent danger.

Skunks seem to enjoy living near man and often build their nests under flooring which is near the ground. They like to bathe frequently, but will not swim unless forced into deep water. Some of the smaller varieties climb trees. The skunk frequently inhabits some hole in the ground, either digging it with his strong plantigrade feet, or more frequently selecting a hole which has already been dug, and from which he may find it his duty to oust the erstwhile occupant.

Skunks breed but once a year, generally in the early spring, and have from six to twelve in a litter sometime in May. The new-born skunks do not open their eyes for some weeks, and are at first hairless in most cases. They follow their mother for six months, at the end of which time they are adult, and breed in their turn the following spring. Although many are still caught by trapping, the number thus obtained would not begin to fill the demand for pelts, so breeding is becoming more and more a profitable industry. Breeders expect that prices for pelts will more than double in the next few years.

Iowa Establishes Child Welfare Research Station

The State of Iowa is to have the credit of establishing the first Child Welfare Research Station. The recent act of the legislature authorizing the appropriation of $25,000 a year for this purpose inaugurates an attempt to do for human life what animal husbandry experiment stations have long done for the conservation of animal life. The work of the station includes six divisions, as follows: (1) Heredity and prenatal care, focussing the resources of the rapidly growing science of genetics upon the problems of parenthood in Iowa; (2) Nutrition of the child, investigating and combating the causes of infant mortality in the State; (3) Preventive medicine, including the study of infant diseases, preventive dentistry, hygiene of the nervous system, and the establishment of standards of normal development for Iowa conditions; (4) Social surveys, giving a basis for legislation on birth registration, sanitary codes, industrial regulation and school attendance; (5) Education and morals, with especial attention to the types of education that may be utilized by parents before the children are six years old; (6) Applied psychology, involving studies in mental health and growth. There is undoubtedly a splendid field for research in each one of these divisions, and the State of Iowa is to be congratulated on engaging in such a beneficent and far-reaching enterprise. —*Journ. Educational Psychology.*

Underfeeding as a Cause of Sterility

One of the most important investigations required in connection with eugenics is of the causes leading to sterility. It is generally believed that overfeeding will produce at least temporary sterility in female animals, and in the *Biological Bulletin* (August, 1917), Leo Loeb publishes experiments with guinea-pigs which show that underfeeding will also lead to the sterility of the female. The possibility that the same cause acting in man might produce the same effect adds interest to the recent announcement from Berlin, that newly-married couples are to be given a double allotment of food during the first six weeks of their married life.

THE BIRTH RATE OF METHODIST CLERGYMEN

Prominent Churchmen Nearly All Married and Have More Children Than Other Men of Similar Education and Social Rank, Despite Their Small Salaries—Marked Evidence of Birth Control

THE EDITOR

THE influence of religious ideals in maintaining a high birth rate has often been discussed by eugenists, but with very few facts to go on. It has sometimes been assumed that religion is antagonistic to the idea of birth control, and that the families in a particularly religious section of the population are larger than the average.

The present paper reports a study of the families of 1,986 persons prominent in the Methodist Church in the United States. Most of them are clergymen. It demonstrates that a remarkably high percentage of them are married, and that the birth rate is considerably higher than among other people of an approximately equal degree of education and social standing, notwithstanding the fact that the average Methodist minister's salary is probably under $900 a year. It is thus seen that religious ideals do have some effect in increasing the birth rate. However, it is a mistake to attribute too much importance to such influence, for the economic influence appears to be more important in determining the size of family. There is marked evidence of much voluntary birth control in the families of these prominent Methodists, and as a whole the group is barely reproducing its own numbers.

The data are taken from "Who's Who in American Methodism," compiled by Carl F. Price and published in 1916. The biographies in this book were furnished by the subjects themselves, and state, among other things, the date of birth, date of marriage, and number of living children. Between 1 and 2% of the individuals included are women, who have been treated as men in tabulating the statistics. This undoubtedly introduces a small source of error, but it is probably pretty evenly distributed.

It appears from a study[1] of the biographies in this book that marriage is, as it is popularly supposed to be, almost universal among clergymen. The percentages are as follows:

Never married	2.56%
Married once	83.98
Married twice	12.59
Married thrice	.84

The small number of single men is remarkable in comparison with Harvard and Yale graduates, of whom from 20 to 25% are celibate. It confirms the popular idea that it is impossible for a clergyman to remain unmarried. Some of those listed as single may yet marry, reducing the percentage still further.

MARRIAGE AT EARLY AGE

The early age at marriage is also remarkable, considering the fact that a young clergyman gets a very small salary, and that other men of his class put off marriage much longer, pleading the expense of marriage as an excuse. The Methodists here considered most frequently marry at the age of twenty-four, and the great bulk of them are wedded before they reach the age of thirty. If a line is drawn at twenty-six years, it is found that just as many marry before as after this age. But at twenty-four the ordinary college man has been separated from his alma mater only a few months. It is evident that a

[1] The data were extracted and largely tabulated by W. L. Altman, of the American Genetic Association. On leaving to take up military service, he turned them over to the editor.

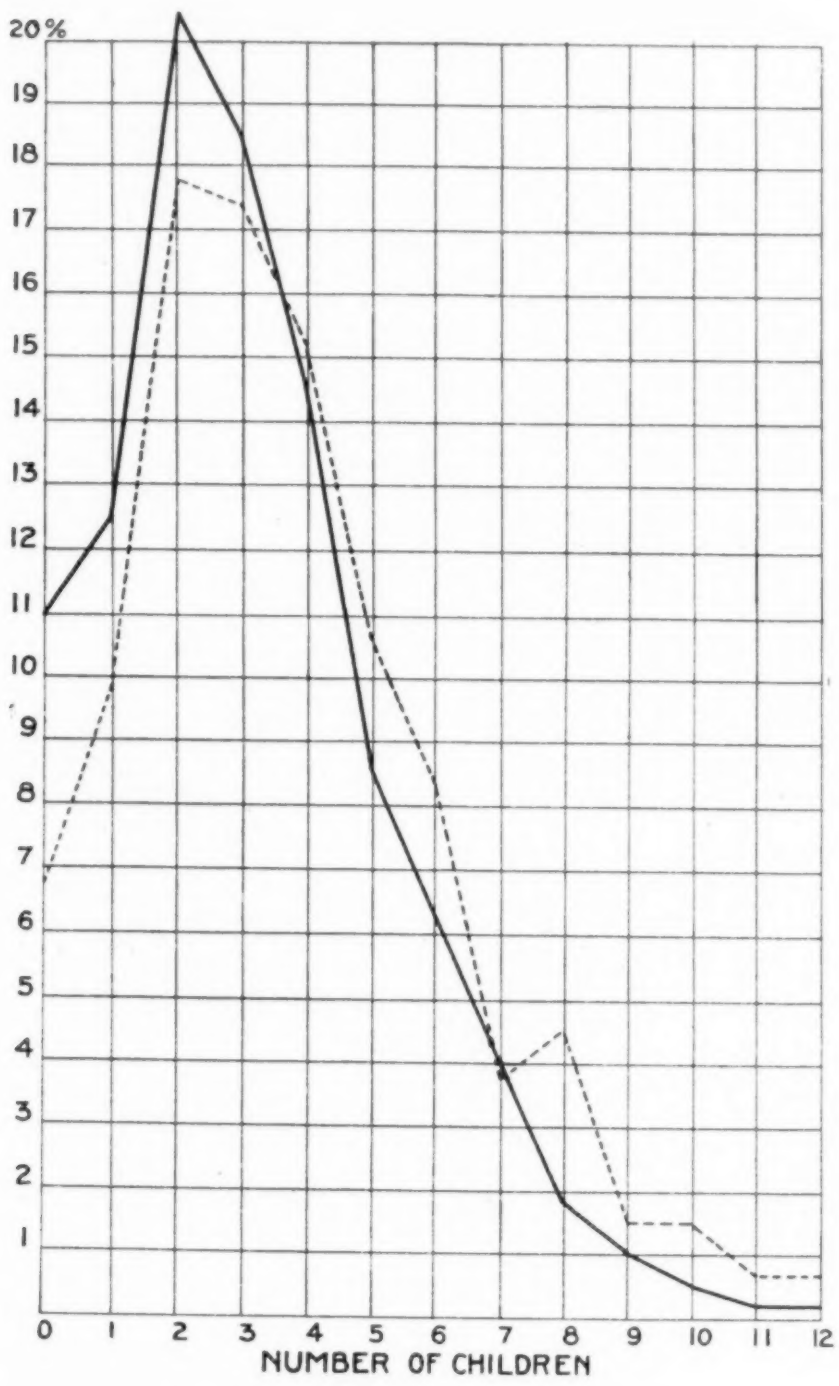
very large number of clergymen must marry shortly after they leave the theological seminary—probably soon after they receive their first appointments. This is doubtless explainable by the fact that ministers as a class are, by reason of their more or less emotional temperament, "marrying men:" that the scope of sexual selection is wide for them; and that a clergyman finds a wife almost a necessity in his pastorate.

Confining the study to those who married only once, it appears that they married at various ages in the following numbers:

Age	*No. married*	*Age*	*No. married*
17	4	37	12
18	10	38	10
19	12	39	6
20	33	40	6
21	73	41	10
22	89	42	2
23	137	43	2
24	174	44	4
25	159	45	3
26	163	46	1
27	153	47	4
28	135	48	1
29	129	50	2
30	91	52	1
31	69	53	1
32	50	56	1
33	48	58	1
34	30	60	1
35	22	65	1
36	18		
Total			1,668
Mean			27.28 years

To calculate the birth rate from these marriages, all were rejected which had not at least twenty years' standing in 1915, when it was assumed that most of the data in the book were compiled. This reduced the number of marriages to 1,512. The entire distribution of the birthrate from these marriages will be found in Table I (at the end of this paper) and is presented graphically in Fig. 6. It is evident that Methodist clergymen have tended to standardize the two-child family, which is so much in evidence among college professors and in other educated classes all over the civilized world. There are more families of two children than of any other size. It must be remembered, however, that all the children dealt with here are surviving children: they have at least passed the perils of infancy. If a line is drawn at 2.3 children, it is found that there are just as many families on one side as the other. This is a dangerously small birth rate, even for a net birth rate. The average is raised (to 3.12 children) only because there are enough large families to counterbalance the larger number of small ones.

Small as it is, this birth rate compares favorably with that of other men of



METHODIST FAMILIES

The solid black line shows the distribution of size of family among prominent Methodists who married but once. The number of childless households is seen to be 11%, and the most frequent size of family to consist of two children, such families making up more than 20% of all.

The dotted line shows the size of families among prominent Methodists who married twice. It might be expected that two women would bear considerably more children than one women, but this is true here to a very limited extent. The most frequent family still consists of two children. (Fig. 6.)

similar social status. J. C. Phillips[2] found that the average number of surviving children of Harvard graduates is 2.17 and of Yale graduates 2.18. If every married woman who demonstrates any ability to bear children brings three to a marriageable age (says Robert J. Sprague),[3] a race will barely remain in equilibrium. If the number of children is smaller than this, the race will decline in numbers. The class of Methodist clergymen is, therefore, just about reproducing its own numbers.

HOUSEHOLDS WITHOUT CHILDREN

The number of childless marriages, 11% of the total, is striking. Part of these are represented as childless in the returns because any children that were born had died before the book was compiled; therefore the actual number of barren marriages is less than here shown. How much less, it is impossible to say. If it be supposed that in one-half of such marriages, children were produced but died (a wholly arbitrary assumption), this would reduce the number of naturally barren marriages to 5.5%. A. O. Powys calculated, from the vital statistics of New South Wales[4] that in a population of Anglo-Saxon mothers of child-bearing age, not more than 2 or 3% are naturally barren; but conceivably a somewhat higher percentage would be barren in North America. It seems safe to conclude that absolutely childless marriage is very rarely desired by Methodist clergymen. Such barren marriages as are found are probably not the result of voluntary avoidance of children. The record of the Methodist clergymen contrasts in this respect with the record of Harvard graduates (decade of 1881–90) who show 23.4% of childless marriages, or of Yale graduates (21%).

But if the wives of Methodist clergymen are not avoiding motherhood altogether, they at least appear to be limiting their families to small size. The great preponderance of one-, two-, and three-child families at once suggests birth control. When an unlimited family all over the world tends to consist of at least five children, there is more than a coincidence in the appearance of so many two-child families among intellectual people everywhere.

Of course, these small families might rather be due to the inferior health of the mother, or to some other biological cause than voluntary birth control. The data do not lend themselves so well as might be desired to a decision on this point. It seems possible, however, to throw some light on it by a comparison of the families of those who married once with the families of those who married twice. For this purpose a separate count was made of all individuals who married twice, and whose second marriage occurred not later than 1900. This practically ensures that the family is now complete. No more children are likely to be born.

FIRST AND SECOND MARRIAGES

To make sure that both marriages existed long enough to be productive, the interval between the two marriages was noted. There were some surprising results—in a number of cases the interval was half a century. On the average, it was 11.5 years. The median line was eight years: that is, the second wedding came less than eight years after the first, in just as many cases as it came more than eight years after the first. Naturally, the first wife must have died several years before the second marriage. But, when all allowances are made, it is evident that the first marriages lasted long enough to make possible the birth of several children, while none of the second marriages had lasted less than fifteen years.

Now if the clergyman's small family is due to debility of his wife, and to that alone, then the man who has been twice

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[2] Phillips, John C. A Study of the Birth Rate in Harvard and Yale Graduates. *Harvard Graduates' Magazine*, September, 1916, pp. 25–34. This comparison is probably too favorable to the Methodists, for they are scattered all over the United States, while the college graduates referred to are concentrated in the East, where the birth rate is probably lower than in the West.

[3] Sprague, Robert J. Education and Race Suicide. JOURNAL OF HEREDITY, vi, pp. 158–162, April, 1915.

[4] Powys, A. O. Data for the Problem of Evolution in Man. On Fertility, Duration of Life and Reproductive Selection. *Biometrika*, iv, pp. 233–286 (1905).

married ought to have a distinctly larger family than the man who has had but a single wife. It would not be twice as large, because (*a*) the first wife was physically weaker than the average, as witness her premature death, hence she bore fewer children or they were more frequently weak and died; and (*b*) the second wife was in some cases past the child-bearing age when she married.

It is impossible to say how much allowance should be made under (*a*), but a rough allowance can be made for (*b*). It is certain that in most cases a minister would choose as his second wife a woman somewhat younger than himself. The average minister was 27 years old when first married; if his second marriage was even fifteen years after his first, and his second wife only two years younger than himself, she would still be capable of child-bearing. If, then, all second marriages are excluded which took place more than fifteen years after the first, the total number of second marriages will be reduced by 30%. Hence, it seems reasonable to think that if the small families of clergymen are due to the debility of their wives, the man twice married will have at least 50% more children than the man once married.

If, on the other hand, the size of the family is limited voluntarily, in accordance with the minister's economic position, the children of a man twice married will be little more numerous than those of a man once married. The birth rate will be slightly increased, however, because even if a man has by his first wife as many children as he can afford to educate, nevertheless his second wife will desire the experience of motherhood. This is likely to add at least one more child to the family.

The foregoing speculations are not represented as conclusive. They are intended to show that numerous counterbalancing influences are at work on the birth rate but that, on the average, two mothers ought to produce a distinctly larger family than one mother, unless the husband limits the size of the family for financial reasons.

FAMILY LIMITATION SHOWN

What do the statistics show? On the average, a second wife *adds only half a child* to the minister's family. It is impossible to interpret this in any way except as showing that the size of these Methodist families is determined mainly by the intelligent plan of the parents, not by the capacity of the women to bear children. The Methodist clergy appears to offer a good illustration of effective birth control.

The extent of this birth control can be shown in another way. From a study of the marriages of *less than* twenty years duration, it appears that 1,000 Methodist clergymen's wives in the United States bear about 115 surviving children a year. In New South Wales, where there seems to have been little or no limitation of offspring when A. O. Powys collected his statistics, 1,000 Anglo-Saxon mothers bear about 295 children a year. The latter rate is gross and that of the American Methodists net, but as infant mortality is low in Australia, it must be concluded that the reproduction rate among Methodists is less than half the normal rate for Anglo-Saxon women. The causes of this 50% reduction are, of course, complex—it is not intended here to suggest that the low rate is wholly due to voluntary limitation, although it must be largely so.

If the available number of second marriages were larger, important conclusions might be drawn from a study of the childless families. Actually, any conclusions drawn can hardly be taken seriously. With this warning, it can be shown[5] that there are four times

[5] As 11% of the single marriages are childless, the chance that a clergyman will have no children by his first wife is $^1/_9$. The chance that his second wife will likewise be childless is $(^1/_9)^2$, or $^1/_{81}$. Making allowance for those cases where the second wife was possibly beyond the child-bearing age when she married, the percentage of childlessness among the twice-married is 4.9, when chance allows but 1.2%. If the various assumptions involved in this reasoning are valid, it must be concluded that three-fourths of the childlessness among the twice-married is either voluntary or due to the husband—probably the latter. But, as stated above, the numbers involved are not large enough to give the example any weight.

more childless families of clergymen who married twice than was to be expected. If these figures have any validity, they suggest that the childlessness (where not due to the death of all children) is due to sterility of the husband and not to barrenness of both wives. It is to be hoped that someone who has records of a larger number of cases where two marriages were childless will test them by this method and throw light on the problem of involuntary childlessness—a problem of great importance to eugenics.

GALTON'S CONCLUSIONS

It would be worth while for someone to send a questionnaire to clergymen, and find out to what extent their small families are due to economic causes, and to what extent health is responsible. Sir Francis Galton's report[6] would seem to attribute a larger part to physical causes than has been done in the present paper. From a study of 196 eminent English divines, he reached the conclusion: "That they are not founders of families who have exercised a notable influence on our history, whether that influence be derived from the abilities, wealth, or social position of any of their members. That they are a moderately prolific race, rather under than above the average. That their average age at death is a trifle less than that of the eminent men comprised in my other groups. That they commonly suffer from overwork. That they usually have wretched constitutions, . . .;" indeed, he is in another paragraph "compelled to conclude that robustness of constitution is antagonistic, in a very marked degree, to an extremely pious disposition."

Wretched constitutions do not seem so characteristic of the modern clergymen as they were of the divines studied by Galton. Perhaps the minister today is not so "extremely pious," or perhaps with very bad health he cannot keep up the work involved in a pastorate. At any rate, the facts presented in this paper all seem to indicate that the size of the family among the most prominent American Methodists is due more to voluntary limitation than to any other single cause.

With the low salaries paid to ministers, it is remarkable that the amount of limitation is not greater. The clergymen are making a larger eugenic contribution to the race than are most other groups of similar standing—a fact probably accounted for in part by their inherent emotional nature and in part by the influence of their religious idealism. If more adequate salaries would encourage a higher birth rate in the ministerial profession, it is earnestly to be hoped that the church will rise to the occasion.

TABLE I

No. of children in family	Once married		Twice married	
	No. of families	Per cent	No. of families	Per cent
0	167	11	9	6.8
1	189	12.5	13	9.9
2	309	20.4	25	18.9
3	281	18.5	23	17.4
4	221	14.6	20	15.1
5	130	8.6	14	10.6
6	94	6.2	11	8.3
7	61	4.0	5	3.8
8	28	1.8	6	4.5
9	15	1.0	2	1.5
10	9	0.5	2	1.5
11	4	0.2	1	0.7
12	3	0.2	1	0.7
14	1	0.06	.....	.....
.....	1,512	.....	132	.....

All families of "once married" had a duration of twenty years or more. All families of "twice married" had a duration of fifteen years or more for the second marriage.

Mean family of "once married," 3.12, $\sigma = 2.06$.

Mean family of "twice married," 3.73, $\sigma = 1.32$.

[6] Galton, Francis. *Heredity Genius*, pp. 270, 274, etc. New York, 1877.

THE TOO-PERFECT MILKWEED

Its Method of Covering Insect Visitors with Pollen, to Insure Proper Cross-Fertilization of the Species, Appears to Have Been Carried beyond the Height of Perfection, so That it Now Defeats the Purpose for Which it is Intended

IN HER attempts at specialization, Nature is often startlingly successful, but there are a few instances, among both animals and plants, where this specialization has overreached the capacities of the organism specialized, and thus the specialization has defeated its own ends. The classic example of this is, of course, the Irish stag, whose highly developed antlers enabled it to overcome its opponents in the struggle for existence. If the development of the horns had stopped at this stage, all would have been well, but the horns kept on increasing in size until they became so enormous that the stag was unable to support them, and the species finally came to extinction.

A more familiar, though less striking, case of adaptation carried too far is presented by the common milkweed or silkweed of the eastern United States (*Asclepias syriaca*), whose specialized flowers appear to have developed further than is really desirable. Although this over-specialization may be dooming the plant to eventual extinction, the milkweed is at present one of the sturdiest and most ubiquitous weeds in the eastern part of the United States, and so far certainly gives no evidence that it is losing out through any hypertrophy.

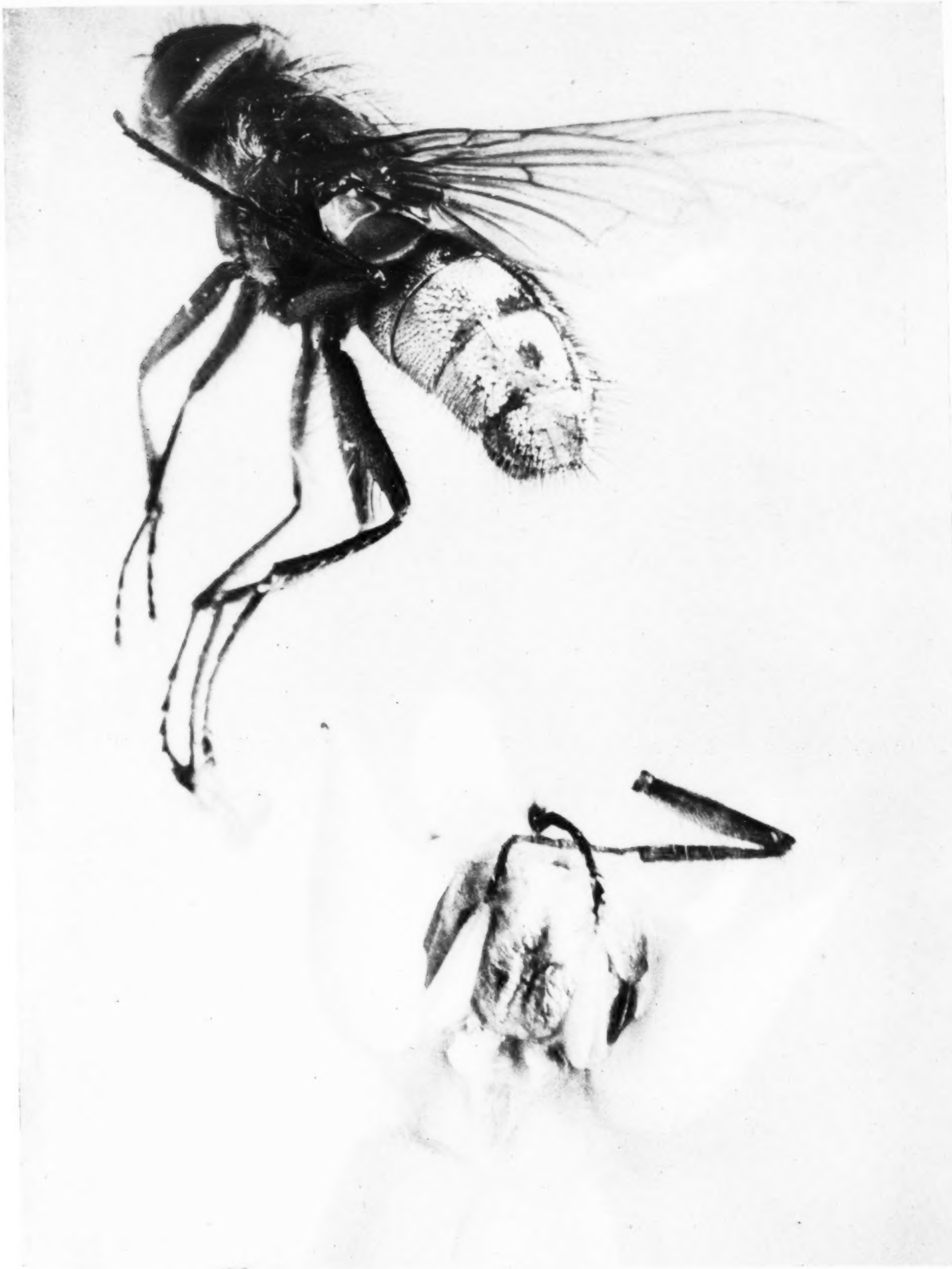
Due to the fact that it is never self-fertilizing, the milkweed depends entirely on insects for distributing the pollen from plant to plant. Evidently, if it was made too easy for insects to secure nectar, they would drink their fill and fly away without carrying much pollen. It was an advantage to the species to make the insect struggle in the flower, thus thoroughly covering itself with pollen which would be carried to the next blossom.

To assure a struggle on the part of the insect, the plant developed a sticky juice which exudes through the petals. This serves the double purpose of making the insect move violently in order to get away, thus bringing its feet and legs in contact with a large quantity of pollen, and also of coating the feet and legs with the sticky substance, so that the pollen grains would adhere more readily.

Thus far the plan would succeed admirably, but the specialization was not arrested at the height of its usefulness, but continued developing until many insects are maimed, crippled or killed by the action of the sticky substance, as shown in Fig. 7. Thus the plant appears to defeat its own ends by causing the insects to be so crippled that they are unable to carry on the work of fertilization as was originally intended, and furthermore, the large deposit of pollen which is placed on the insect's feet is lost, and hence not available to the next visitor.

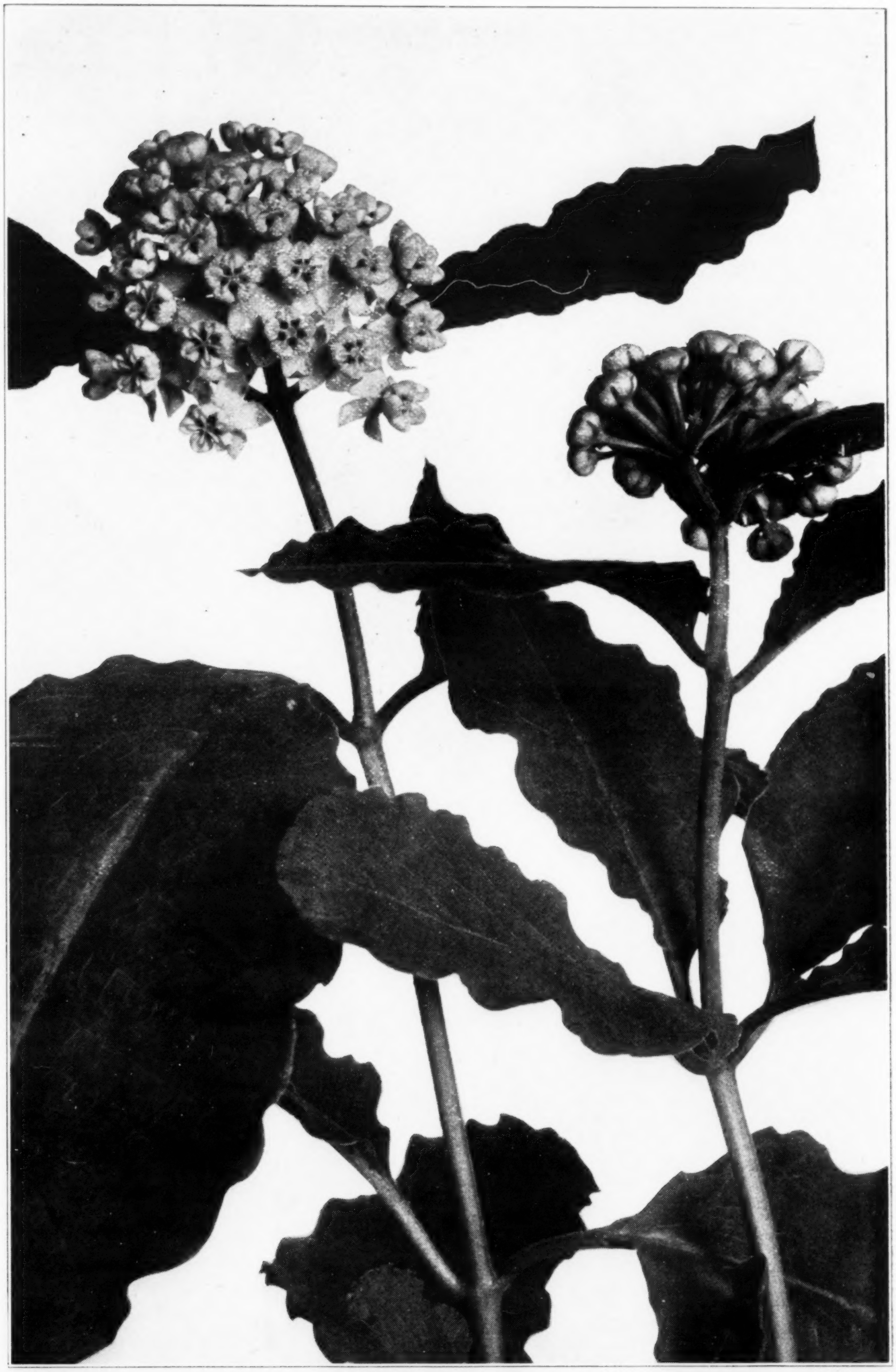
In the accompanying illustration (Fig. 7) is shown a flower with two legs, belonging to a recent visitor, still sticking to the petals. It may easily be seen that the former owner of these legs would probably be of little further benefit to milkweeds. Just above the flower is pictured a fly with the third leg on the left side gummed fast to the left wing, so that it is impossible for it to fly, thus effectually preventing it from fertilizing other flowers. From these two instances, the disadvantages accruing from this over-specialization are self-evident.

In the other picture (Fig. 8), two sprays of the plant are shown natural size, so that it is more easily recognized than in the photograph of a single flower greatly enlarged. The spray on the left shows the beautiful flowers, while that on the left is a head of buds. The stem is tall and stout, and fre-



A PLANT THAT HAS OVERREACHED ITSELF

This milkweed developed a sticky juice, presumably to keep insects from getting into and out of its flowers too quickly, and to ensure that they would get well covered with pollen before they left. The device works rather too well for the good of the species. Two legs left by a recent visitor can be seen in the flower; it is probable that that particular visitor will not cross-pollinate any more milkweed blossoms, therefore all the pollen which he carried away is wasted. Above is a fly which, in visiting the flower, became so gummed up as to be unable to get away, a foot being stuck to a wing. Copyrighted photomicrograph by A. G. Eldredge, University of Illinois. (Fig. 7.)



THE COMMON MILKWEED

Although this plant, as shown in Fig. 7, is playing a dangerous game in its attempts to secure cross-pollination, it seems to be succeeding so far, for it is one of the most widespread weeds in the United States. Photograph by Dr. R. W. Shufeldt in *American Forestry Magazine*. (Fig. 8.)

quently covered with very fine hair, which may be visible only with the aid of a hand lens. The leaves are large, broad, short-petioled, and pubescent on the under side. The flowers, as has been mentioned, are quite complex in structure. This plant crosses freely with other Asclepiadaceae, producing hybrids which often present interesting features for study.

Galton, a Child Prodigy

Francis Galton, the founder of eugenics, was one of the most precocious children on record, according to Lewis M. Terman of Stanford University. Professor Terman has been studying the documents presented in Karl Pearson's admirable Life of Galton, and publishes his conclusions in the April issue of the *American Journal of Psychology*.

Between the ages of three and eight years Galton's mental achievement was at least twice that of the normal child, he thinks: that is, Galton at the age of five was as far advanced as the ordinary child of ten. At the age of four, he believes Galton had a 9-year-old intellect. This record is unequaled by any other that is as well substantiated, Professor Terman declares. In his own examinations of several thousand school children in the United States and Canada, he has never found one who was thus 100% ahead of his age, nor even 75% advanced; and the number who are 50% advanced is so small that it can be reckoned on the fingers of one hand.

Improved Wheat Produced by Ohio Station

By methods of selection improved strains of wheat have been developed at the Ohio Agricultural Experiment Station that surpass standard varieties by more than two bushels to the acre. Four million bushels more wheat might be raised in Ohio if all farmers were to sow such seed.

Many selections are discarded in these comparative tests made at the Experiment Station because they cannot withstand severe winters. Others have weak straw and are taken out of the competition on this account. A few make poor flour and bread even though they yield well. All the selections must yield more than the old standard varieties from which they were chosen, if they are to be long continued as promising new strains.

Few Women Medical College Graduates Marry

As women who follow scientific careers are on the average of superior intellectuality, their marriage rate is a matter of interest to eugenists. A study of the John Hopkins University medical graduates shows that in the years 1897–1907 inclusive, sixty women received the degree of M.D. Three of these have since died. Of the fifty-seven living, twenty-one have married and thirty-six are still single, although ten years after graduation they have reached an age when they are not likely to marry. The marriage rate of these women may, therefore, be taken at 36.8%. This is a lower rate than any general women's college shows, but perhaps no lower than the women who take the degree of Ph.D. in colleges would show. The failure of so many of the women doctors to marry is, doubtless, largely due to the fact that they are by nature inclined toward a career rather than to matrimony; and in part to a prejudice which many men have against a woman "who knows too much."

ELIMINATING FEEBLEMINDEDNESS

Ten Per Cent of American Population Probably Carriers of Mental Defect—If Only Those Who Are Actually Feebleminded Are Dealt with, It Will Require More Than 8,000 Years to Eliminate the Defect—New Method of Procedure Needed

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IN AN article on "Hidden Feeblemindedness," which appeared in the JOURNAL OF HEREDITY for May, 1917, Dr. E. M. East raises a point of great practical importance for students of eugenics. Briefly, it amounts to this: if we know the proportion of individuals exhibiting a simple recessive character in a given population, can we decide what proportion of the dominants is heterozygous? Under certain conditions, the required answer can be readily and easily obtained. Some years ago, G. H. Hardy[1] showed that a mixed population containing p homozygous dominants, r recessives, and $2q$ heterozygous dominants was in stable equilibrium when the equation $pr=q^2$ was satisfied. It was assumed that there was random mating and equal fertility among the different classes. Hardy further showed that if the condition of equilibrium were upset through some disturbing agency the population would rapidly fall into a new position of equilibrium which would be maintained in the absence of any fresh disturbance. If we know that one of the two classes of homozygotes is less numerous than the other we can simplify the equation by considering the less numerous class as unity. Let us suppose that the recessives are less numerous than the homozygous dominants so that $p=xr$ where x is some number greater than one. Then if $r=1$, the equation $pr=q^2$ becomes $x=q^2$, and for an population in equilibrium the number of heterozygotes $(2q)=2\sqrt{x}$. The total population thus consists of the three classes: homozygous dominants, heterozygotes, and recessives in the relative proportions $x:2\sqrt{x}:1$. Now if we know the percentage of recessives in the total population, we can easily calculate the relative numbers of the three classes. For instance, in the case at issue, Dr. East states that the proportion of feebleminded in the population of the United States is 3 per 1,000, or 1 in 333. Here therefore:

$$\begin{aligned} x+2\sqrt{x}+1 &= 333 \\ \therefore\ (\sqrt{x}+1)^2 &= 333 \\ \therefore\ \sqrt{x}+1 &= \sqrt{333} \\ \therefore\ \sqrt{x} &= 17.25 \\ \therefore\ 2\sqrt{x} &= 34.5 \end{aligned}$$

In other words, the proportion of heterozygotes in such a population is rather more than 10%. The proportion is somewhat higher than the 7% arrived at by Dr. East, though we must remember that he considers his result to understate rather than to overstate the facts.

In making the above estimation of the proportion of heterozygotes, certain assumptions have been made. Like conditions must hold with regard to the birth rate and death rate of the different classes, the distribution of the factors must be similar in both sexes, and there must be no selective mating. Further, the population at any given moment must be supposed to be in equilibrium or very nearly so. In the paper cited above, Hardy showed that if a state of equilibrium were upset by some disturbing agent, a new state of equilibrium

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[1] *Science*, July, 1908.

would be immediately established, and would persist as such after a further generation provided that no fresh disturbance arose. If the disturbing cause were small, the new position would be so close to the old that, for practical purposes, the population might be regarded over a few generations as unchanged.

The seemingly large proportion of heterozygotes entailed in a stable population by even a small proportion of recessives helps us to understand a feature of certain collections of human pedigrees which at one time appeared puzzling. Albinism, for example, behaves on the whole as a recessive. Nevertheless, albinos appear among the offspring in an appreciable proportion of matings where either one or both parents are normal, and where no consanguinity can be detected. The same is true of feeblemindedness. This becomes less difficult to understand when we realize that the heterozygotes are bound greatly to outnumber the recessives whenever these form a small proportion of a stable population.

There is a further point which merits brief consideration. At what rate can we hope to free a population of an undesirable recessive character by isolating, or by otherwise sterilizing those individuals which exhibit the character? In a recently published book[2] I have been able through the kindness of Mr. Norton, of Trinity College, Cambridge, to give a table showing the rate at which the constitution of a population changes when either the dominants or the recessives are subjected to selective elimination of known value. In this table, however, the most intense form of selection dealt with is the elimination of 50%, at each generation, of the dominants or recessives. Though it is unlikely that legislative measures, unless very stringent, would succeed in getting rid of a higher proportion of feebleminded without their leaving offspring, it may yet be of interest to enquire how rapid the rate of elimination would be if all feebleminded were henceforth eliminated completely, from the breeding stock of the population. I am indebted to my friend G. H. Hardy for kindly working out for me the brief table appended. Assuming that all recessives are eliminated, their proportion in the population passes

From 1 in 100 to 1 in 1,000 in 22 generations.
From 1 in 1,000 to 1 in 10,000 in 68 generations.
From 1 in 10,000 to 1 in 100,000 in 216 generations.
From 1 in 100,000 to 1 in 1,000,000 in 684 generations.

If therefore the proportion of feebleminded in the United States is 3 per 1,000 today it would require something over 250 generations, or about 8,000 years, before the proportion was reduced to 1 in 100,000, and nearly four times this length of time before the feebleminded were as few as 1 in a million. The prospect of the success of the segregation method is not hopeful. Though it may be sure it is very, very slow. For the rarer the recessive becomes the more frequently, relatively, is it produced through the mating of two heterozygotes. Clearly if that most desirable goal of a world rid of the feebleminded is to be reached in a reasonable time some method other than that of the elimination of the feebleminded themselves must eventually be found. The great strength of this defect in the population lies in its heterozygotic reserves; if the campaign against it is to meet with success it is at these that it must be directed. This is so clearly perceived by Dr. East that we cannot do better in concluding than by quoting the closing sentences of his paper.

"We have assumed that a normal mentality is completely dominant over a defective one. Is this true? Complete dominance is rare among those characters commonly studied by animal and plant geneticists. Is it not likely that the Binet-Simon or other proper tests would show that carriers of mental defects exhibit a lower mentality than pure normals? Would it not be wise to start some investigations along this line?"

[2] *Mimicry in Butterflies*, Cambridge, 1915, pp. 154–156.

CLOVEN HOOF OF PERCHERON

This photograph shows two hoofs on the front leg of a pure bred Percheron colt born and raised at the Delchester Farms, Edgemont, Pa. The sire of this colt was Imp. Kaneton 98952 (97439) and the dam was Lalouve 98981(99154). So far as I am aware, there is no abnormality of the sort in the ancestry. Although there have been several cases of cloven-hoof or polydactylism in horses, this meristic variation is rare. The ancestors of the horse had as many as five toes, but this case is not to be looked on as a case of reversion, as is the appearance of an extra toe in the guinea-pig at the present day. It is rather a type of polydactylism like that in man, where a single finger splits to produce two. This same type of polydactylism by splitting of a single digit is even more familiar in the house cat. In all animals, polydactylism has proved to be inherited in some degree, but in an irregular way. I do not know of any evidence to show how it behaves in the horse. Photograph by C. W. McDonald. (Fig. 9.)

B. O. Severson, State College, Pa.

A New Ancestor for the Goat

It has generally been supposed that all domesticated goats are descendants of the Pasang or Grecian Ibex (see the Journal of Heredity, Vol. vi, pp. 519–525, November, 1915), but Professor Adametz declares this idea is no longer tenable. He has been examining the remains of a new species of goat found in Galicia, to which he has given the name of *Capra prisca*, and thinks that this extinct species is the ancestor of most of the modern breeds. It is quite different from the Pasang. His findings are published in the *Mitteilungen der landwirtschaftliches Lehrkanzeln der K. K. Hochschule für Bodenkultur in Wien*, Vol. iii, pp. 1–21, Vienna, 1915.

English Plans to Increase the Birth Rate

That the English birth rate has steadily declined during the last generation, and that the decline has been greatest in the most valuable part of the population, are conclusions of the National Council of Public Morals, which has published its extensive investigation in a substantial volume (*The Declining Birth Rate*. London, 1916). A supplementary report outlines a number of measures which it is believed might help to secure a more adequate birth rate, in quality as well as quantity.

1. Minimum wage for workers.
2. Bonuses for all children who reach the age of fourteen, in families where the income is less than $500 or $600 a year.
3. Taxation of income of husband and wife separately, with a substantial exemption for each child, in the case of all incomes under $3,000 or $3,500 a year.
4. More free higher education.
5. Better housing facilities.
6. Development of means of national subsistence—more intensified agriculture, changes in land tenure, etc.
7. A campaign to educate public opinion to the need for more good children.
8. Simpler living, which would tend to make childbirth less painful for women; and education of women to the fact that with modern surgical technique childbirth is by no means an intolerable ordeal.
9. Public discussion of methods for increasing the birth rate.
10. Teaching fathers to bear a larger part of the burden of parenthood, instead of leaving the mother to take all the responsibility for the children.
11. Awakening teachers of religion and morals to the fact that they are remiss if they do not include eugenics in their teaching.
12. Reduction of infant mortality.

SOMATIC MUTATIONS IN SUNFLOWERS

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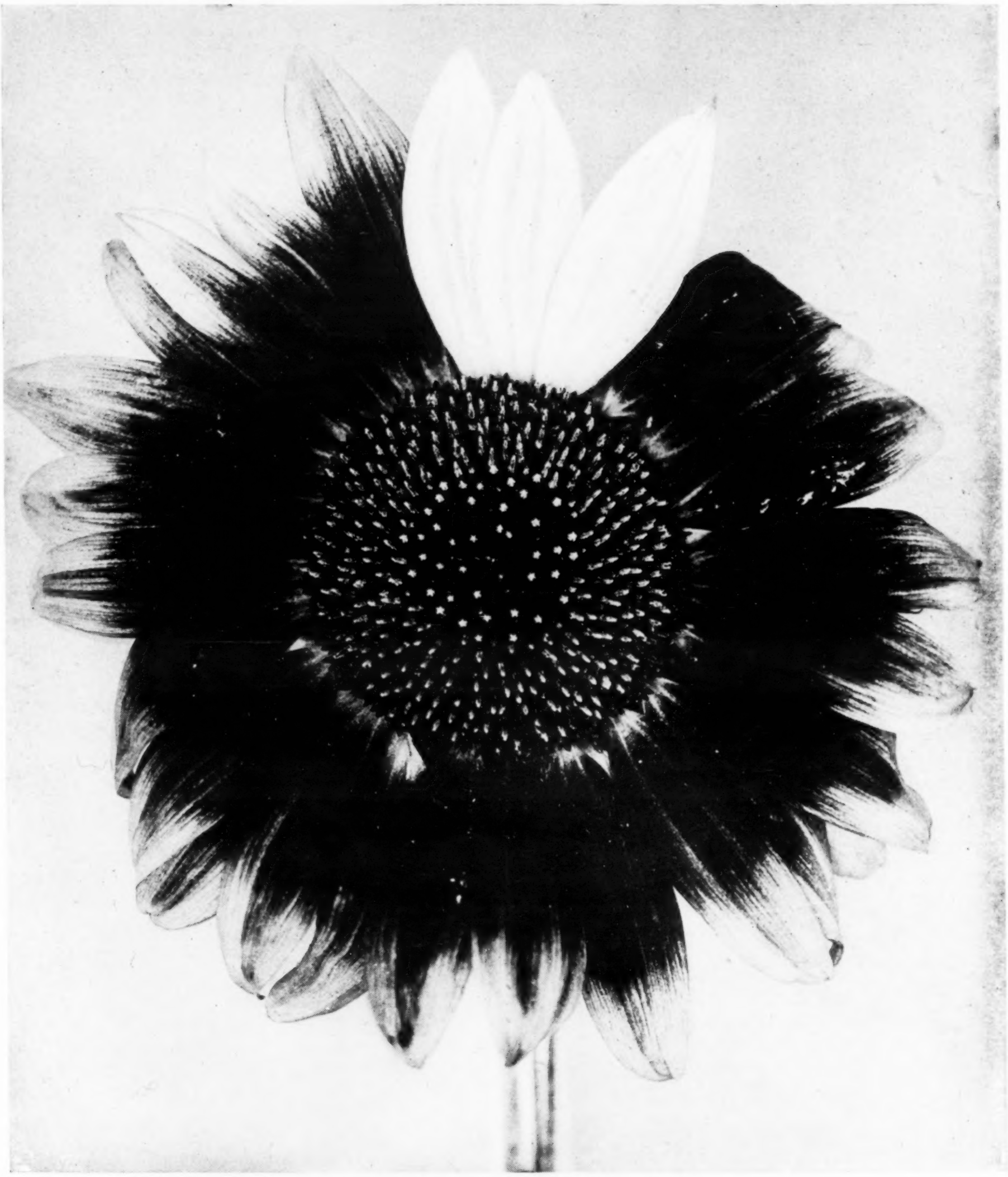
WE USUALLY think that, after fertilization has taken place, the characters of the resulting individual are determined, except so far as they may be modified by environmental influences. There are, however, many facts which show that, while this is generally true, it is by no means an invariable rule. Some of the apparent exceptions are evidently misleading, as when in a bird the loss or disease of the sexual organs results in the appearance of characters belonging to the opposite sex. Such cases are to be classed among those due to the environment, and have nothing to do with any fundamental change in the nature of the inherited qualities. It is quite otherwise with bud-sports in plants, which are capable, apparently, of modifying the offspring of the seeds produced by the affected branch. In all such cases it appears that a change in the hereditary constitution of the cells has occurred in the soma or body, without having any connection with the processes of sexual reproduction. Such changes also appear to be the cause of gynandromorphs in insects; those strange individuals showing the characters of the male in one part of the body, of the female in another. Thus I possess a bee of a species in which the clypeus or facial plate is yellow in the male, black in the female. In this specimen it is yellow on one side, black on the other, the dividing line running exactly down the middle. To such changes, also, we may probably attribute the disease known as cancer, in which certain cells of the body entirely abandon their normal functions. Mouse cancer can be transplanted from mouse to mouse, just as a branch of a tree arising from a bud variation may be grafted on to another tree.

Professors Babcock and Lloyd, in JOURNAL OF HEREDITY, February, 1917, pp. 82–89, have discussed these matters at some length, and object to the expression "somatic segregation" as going beyond the present state of our knowledge. The changes observed could be due either to some modification in a particular cell, due to causes not ascertained; or they could result from inequalities or errors in the process of mitosis or cell-division. Are we at liberty to assume that the latter explanation is correct? It is doubtless better to use a term such as "somatic mutation," which does not commit us to anything more than the fact of the change. At the same time, it must be significant that these phenomena more commonly occur, as East has pointed out, in plants known to be heterozygous. Granting that mitotic errors are extremely rare, if they occur once in many millions of divisions all the observed facts may be accounted for. It is also significant that these variations so often represent the apparent loss of one of the known determiners of the plant. This might, indeed, be due to a mutation of the determiner itself, but it is easier to believe that in a heterozygous cell one of the pair of diverse allelomorphs disappeared, and that this disappearance was due to a mitotic error.

The red sunflower (varieties of *Helianthus annuus*) is unusually favorable material for the observation of somatic mutation. I figure two remarkable heads produced in Boulder by my wife in 1917. In each case the dark rays are deep chestnut red, more or less tipped with yellow, while the pale rays are yellow. In one it will be seen that three rays are yellow, the rest red. In the other it is about half and half. The latter head is remarkable in several ways. The yellow rays are weakly suffused with red, showing that they do not wholly lack the factor for redness. Either they possess an inhibitor or they lack a factor for full color. It will also be noted that on one side the dividing line between the red and

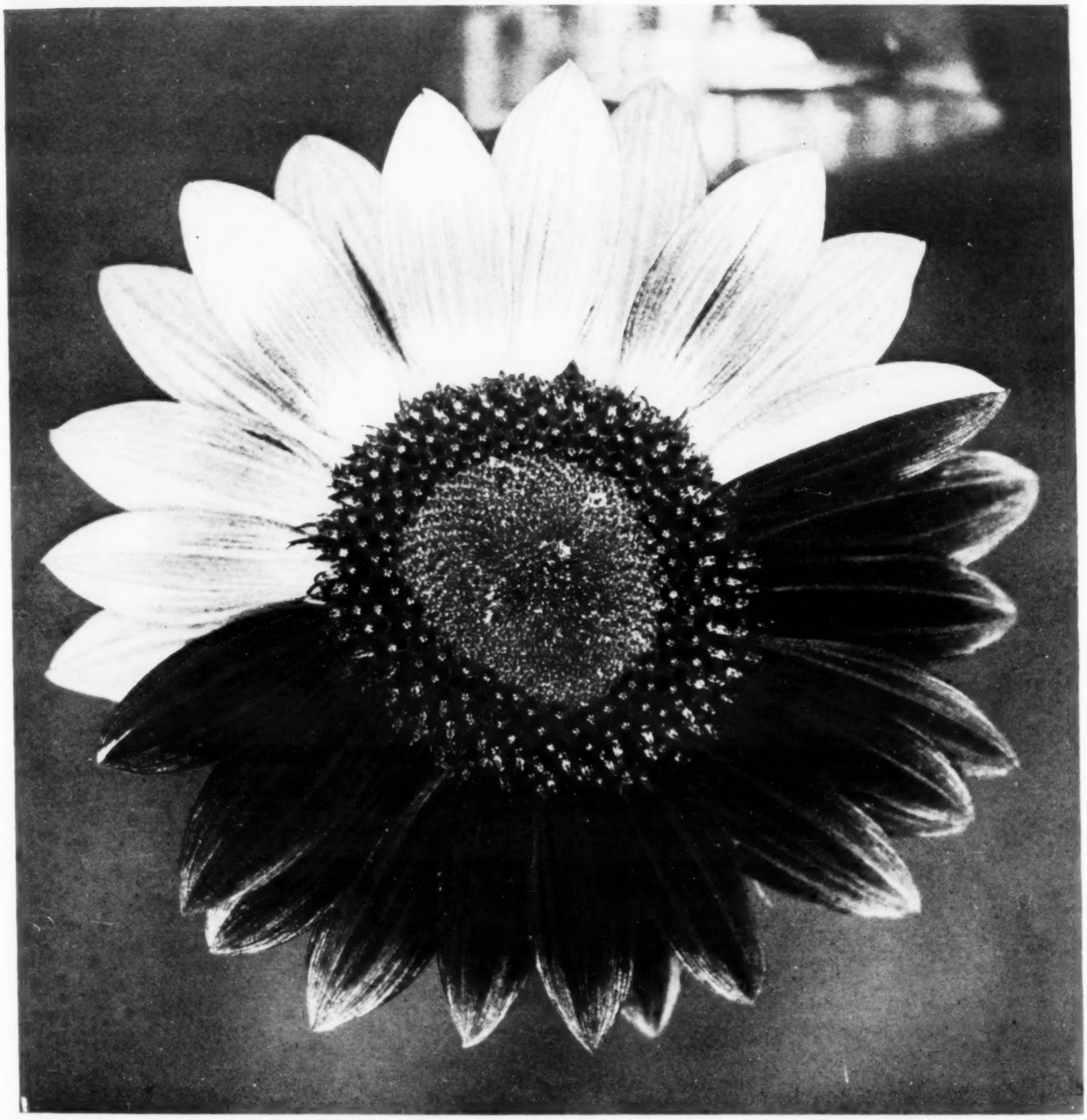


A BEAUTIFUL EXAMPLE OF SOMATIC MUTATION

Normally this sunflower is solid chestnut red. Some change has apparently taken place in the constitution of part of the cells which formed this flower, with the result that the red has been replaced by yellow in three rays. (Fig. 10.)

the yellow runs down the middle of a ray. On the other side, the first red ray has a little pure yellow on one side of the tip.

Last year I found a head with the rays orange, except that three were red, and on each side of the three was a ray exactly half red and half yellow, the red side, of course, toward its red neighbor. Other heads on the same plant, though not all, showed more or less of the same character. Another plant in 1916 had three heads in which about half (one side) of the rays were quite strongly red, the other half with little red. The three heads were not quite alike, one having over half the rays strongly red. Another remarkable



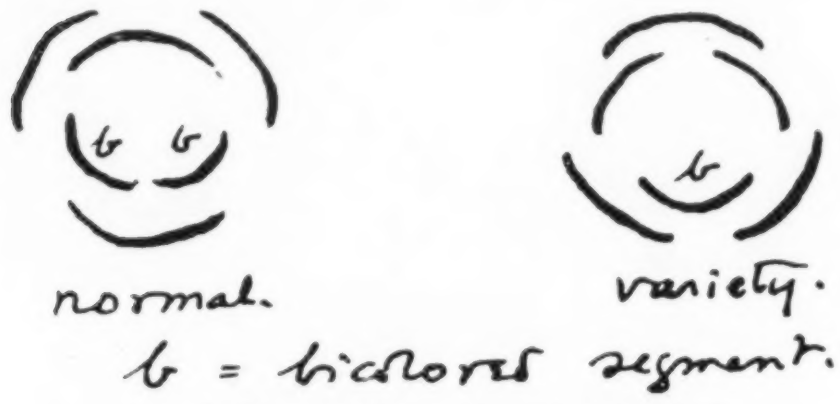
WHAT IS THE EXPLANATION OF THIS CHANGE?

Instead of a solid red, this sunflower is nearly half yellow. In one case the dividing line between the two colors runs down the middle of a ray. The yellow color is not very clear, but is suffused with red. Generally mutations are supposed to occur only in germ-cells, and strong objections have been made by some writers to assuming that they take place in body-cells. But cases like this sunflower seem to be more easily explained by the latter hypothesis than by any other. (Fig. 11.)

case was of a different sort. In a sunflower with fine dark red rays were three heads, each lacking altogether about two rays, leaving a space. The outer disc florets were also lacking at the same place. The three heads were on quite different long branches, extending from three different sides of the stem. Here the mutation apparently had lethal results.

My colleague, Dr. Geo. Norlin, who specializes in dahlias, showed me last year a singular variety called cockatoo. The flowers are lemon yellow, but some heads have the flowers white, faintly pinkish, the rays lemon at base. Dr. Norlin tells me that this production of diverse heads on the same plant is a regular character of this variety. This is suggestive of chemical instability,

and may not be a case parallel to those described in sunflowers.[1]



A CHANGED GLADIOLUS

Diagram of the flower with segments reversed, described in footnote to the text. This reversal of orientation did not affect the shape of the flower nor a change in the relative location of the dark marking. It is evident, therefore, that these things are due to independent factors. (Fig. 12.)

It is natural to recall the brilliant researches of Bridges, showing that irregularities in chromosome distribution produce the most far-reaching results. Thus in *Drosophila* the individual with one X-chromosome is a male, with two a female, but that with three is not viable. In the fertilization of plants it seems that a quantitative difference decides what shall be embryo and what endosperm. Can such differences arise in somatic mitosis? My colleague, Dr. R. C. Whitman, assures me that the cancer irregularities in mitosis, resulting in inequalities in the distribution of chromatin, have actually been observed.[2]

I take this opportunity to state that the title of my paper in the JOURNAL OF HEREDITY, August, 1917, should have been simply "Sunflower Seedlings." The first three words, which are not applicable, were added after the proof left my hands.

Decline of Germany's Birth Rate During the War

In German cities, it is stated, the birth rate for 1916 was nearly 40% lower than that for 1914. Infant mortality was higher than usual. Similar conditions probably prevail in most belligerent countries, although in England the infant mortality decreased during the first two years of the war. It seems likely that the infant mortality would be highest among the poor and ignorant, but it is conceivable that the decline of the birth rate may be greatest among the most highly educated and carefully nurtured women. If so, it will be a serious dysgenic effect of the war.

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[1] Another case, evidently belonging to a different category, is that of a pink-flowered gladiolus now before me. The lateral inferior segments of the perianth are smaller than the others and are strongly bicolored, the base deep purplish-rose, the apical part (except the pale pink margin) clear pale yellow. On one spike, while the upper flowers are normal, as just described, the lower ones have only one of these modified segments, which is central. It overlaps the two large lower ones, which are like the upper; whereas in the normal flower the large median lower segment is overlapped by the bicolored ones. In this case there has occurred a reversal of the orientation of the perianth segments, so that instead of having two outer above and one below, and one inner above and two below, there are two outer below and one above, and two inner above and one below. This has not affected the general shape of the flower, nor has it caused a reversal of the orientation of the dark marking, affording a curious illustration of the independence of the three factors.

[2] I have recently found a garden *Canna*, with flowers normally bright yellow, the petals profusely spotted with bright red, in which one flower on a spike was abnormally colored. In this flower two of the petals were entirely brilliant red, while a third had exactly one-half red, and the other half yellow with the elongate red spots. The dividing line is exactly in the middle, and is absolute. This is quite similar to the bicolored sunflower ray, and it is especially interesting as showing in a single petal the two types of bicoloration: one (the spotting) due to a pattern factor, normal to the plant; the other one to cell mutation or somatic segregation. On the segregation hypothesis we should apparently be compelled to suppose that the full red type was recessive to the spotted. Does any reader know whether this is the case in Cannas?

It is also to be remarked that the somatic mutation or segregation evidently took place at an early stage in flower formation, and both the canna and the sunflower indicate that the foundation of any single petaloid element is bicellular. The canna petal must have been derived from contributions from two already different types of cells, one destined to produce the red, the other the spotting. The exactly equal contributions indicate an early bicellular condition, not the fusion of two multicellular groups.

ORIGIN OF THE STRIPED CANE

A. D. SHAMEL, *Riverside, Cal.*

ARUNDO DONAX, Linn. is a tall, reed-like grass with broad, flat leaves, and large plume-like flowers. It is sometimes called the giant reed, and is often erroneously mistaken for the bamboo to which it is only distantly related. In England the stems are said to attain a height of 8 or 10 feet, but in southern California they frequently grow 18 or 20 feet high. The stems are sometimes used in making the reeds of the oboe, bagpipes and some other musical instruments. It is said[1] to be probable that *Arundo Donax* is one of the plants alluded to in the Scriptures as the Reed. The canes are long, straight and light, making excellent fishing poles and arrows. The latter quality was of great importance to the warlike Jews after they began to practise archery with effect. The heroes of Homer made their arrows of this reed (*Iliad xi*), and the tent of Achilles was thatched with its leaves. The canes were also used in making a great variety of useful articles including looms, baskets, and fish traps, according to some of the older herbals. At an early date in history this reed was widely grown over the south of Europe, Egypt and other nearby regions.

In southern California *A. Donax* is occasionally found in the gardens and grounds of some of the homes but more commonly a striped variety, *A. Donax* var. *variegata* is used for ornamental planting. At the foot of Victoria hill, near the writer's home, there is a fine clump of the variegated *Arundo Donax*. Only one or two plants were originally set out, about 1902, but in a dozen years the plants had spread until they occupied a space of about 200 square feet. The boys in Riverside secure many of their favorite fishing poles from selected canes of these plants. The canes are also very popular with gardeners who use them for staking beans and other climbing plants. Neighbors obtain many rootstocks from this group for ornamental planting. In 1914 all but a very few of the plants were transplanted to other locations, but at the present time, three years later, the group has been partly regrown from the few rootstocks left in the ground.

The canes of this variety are small, usually not more than about one-half inch in diameter, are comparatively uniform in thickness from base to tip, and frequently attain a length of from 12 to 15 feet. The leaves are numerous, cordate-clasping and hairy at the base, about 2 inches wide and from 15 inches to 2 feet in length. The leaves are striped, usually alternately green and white, giving the groups of plants a striking and beautiful appearance.

On a recent examination of the Victoria hill group of variegated plants, the writer noticed that some of the canes possessed leaves that were not variegated. On further study some variegated canes were found to have one or more sections bearing green leaves as shown in Fig. 13. In some cases green and variegated canes grow from different buds on the same rootstock.

Observation of variegated plants in this and other locations reveals the fact that the amount of white color, *i. e.*, the width and arrangement of the white stripes in comparison with the green stripes, varies greatly in different plants and sometimes on the same plant. Some plants have leaves in which the white stripes are several times as broad as the green ones, while in others the reverse condition prevails.

Inquiry has brought out the fact that several strains of the variegated canes have been isolated through the selection of offshoots. In other words the strains have originated as bud variations and have been propagated through bud selection.

The variegated bud sports probably must have occurred in *A. Donax* for hundreds of years. In Green's and other old herbals mention is made of the variegated or striped varieties.

[1] Treasury of Botany, p. 98.

AN ORNAMENTAL BUD-VARIATION.

Part of *Arundo Donax* plant showing both striped and green leaves. At the base of this particular reed, which was 12 feet in length, the leaves were striped as was the case at the top. In this group of reeds some of the individual reeds have wholly striped leaves and others wholly green leaves. (Fig. 13.)

The variegated canes are usually not so tall nor their leaves so large as those of the green plants in this locality. During the heavy frosts of January, 1913, the tender growth of the variegated plants was more severely injured than that of the green ones; the green plants therefore seem to be somewhat more hardy than those of the variegated variety.

This case is presented for the purpose of calling attention to the origin of a valuable variety of plants through bud variation and its isolation through bud selection.

COLOR INHERITANCE IN MAMMALS

IV. The Rabbit—Has Three Sets of Multiple Allelomorphs Which, as in Six Other Cases in Mammals, Determine Linear Series of Physiological Effects Not to be Explained as Mere Linkage of Factors in the Germ-cells

SEWALL WRIGHT
Bureau of Animal Industry, Washington, D. C.

RABBITS are very rich in color varieties and more unit differences from the wild gray have been thoroughly demonstrated than in any other mammal. The ten known unit differences listed in the box below fall into seven independent sets of allelomorphs. In three cases triple allelomorphs have been proved. Most of the possible combinations of these factors have been made but partial coupling does not seem to have been thoroughly investigated.

The two white patterns—English and Dutch—make an interesting comparison. Hurst[1] showed that the Dutch pattern is due to a unit factor which is nearly recessive. Heterozygotes generally show a small amount of white. There are all variations in the pattern from a very little white to black-eyed white, but the mode of inheritance of these differences has not yet been solved. Hurst[2] found the English pattern to be dominant on the whole, although the heterozygote shows distinctly more color than the homozygous English. These results have been confirmed by all later work.

The fundamentally different biochemical nature of the two patterns was shown by Onslow as discussed in the first paper of this series. He found an enzyme inhibitor in the skins of English rabbits but merely an absence of the enzyme, tyrosinase, in Dutch rabbits. There is considerable difference in appearance. As in other piebald mammals, the Dutch rabbit has large colored areas with solid boundaries sharply separated from the white parts. In the English pattern, there is a greater breaking up of the spots and at the borders white and colored hairs are intermingled. This pattern holds a somewhat isolated position at present. It can hardly be compared with the so-called dominant white of mice which seems to belong to the piebald class. It is perhaps most closely allied with the dominant whites among the larger animals as in the white of Shorthorn cattle or of sheep. In these, however, there is a tendency toward a uniform roan in the heterozygotes. On this basis, the English factor is put in class $1a_1$, while the Dutch factor is put in class $1a_2$.

The maltese type of dilution is familiar in rabbits and was found by Castle[3] to be a Mendelian recessive. This factor reduces yellow to cream as well as black to blue. It resembles closely

Wild Gray Rabbit—w S I C A E B (Pattern of black and yellow)

$1a_1$	W,w	W—English pattern
$1a_2$	S,s	s—Dutch pattern
$1a_3$	I,i	d—dilute gray (blue and cream)
1b	C, C_h, C_a	C_h—Himalayan, C_a—albino
$2a_1$	A, A_t, A_b	A_t—black and tan, A_b—black
$2a_2$	—	
$2a_3$	E_d, E, E_y	E_d—black, E_y—yellow
2b	B,b	b—brown agouti (brown and yellow)

Classification explained in paper on the mouse, JOURNAL OF HEREDITY, 8:373, August, 1917.

[1] Hurst, C. C. 1905. *Linn. Soc. Jour. Zool.*, 29:283–324.
[2] Hurst, C. C. 1906. *R. Hort. Soc. London*, p. 114.
[3] Castle, W. E., Walter, H. E., Mullenix, R. C. and Cobb, S. 1909. *Carn. Inst. Wash. Pub. No.* 114. 68 pp.

the dilution of mice and may well be put in the same class.

ALBINO SERIES OF ALLELOMORPHS

The Himalayan rabbits resemble albinos except that they show a brownish-black color at the points. They never show yellow under any conditions. Perfect albinos are also well known in rabbits and Castle[4] found that each of these types segregated from crosses with fully colored rabbits without producing the other and, in crosses with each other, also followed unit Mendelian inheritance. He concluded that the Himalayans contain a modification of the color factor. The series of three variations agrees well with the series of four in guinea-pigs and of three in rats. It is interesting to note, however, that the lowest known albino allelomorph in guinea-pigs seems to correspond rather with the Himalayan than with the perfect albino in rabbits.

AGOUTI SERIES OF ALLELOMORPHS

As in other rodents, black was early found to be a simple recessive to gray.[5] An intermediate condition is known in the black-and-tans in which the back is black with only a few ticked hairs while the belly is white and yellow. This was shown by Castle and Fish[6] to be due to an intermediate variation of the same factor by which grays differ from blacks. This series of three allelomorphs is naturally to be compared with Cuénot's series of four in mice: yellow, light-bellied gray, gray-bellied gray and black. The sequence of effects seems different but such a difference may well be due to independent causes. It may be pointed out that in a stock of mice with a higher density of black than usual (due to factors of class $2a_3$) the sequence of effects produced by the four agouti allelomorphs approaches that in rabbits.

DENSITY SERIES OF ALLELOMORPHS

The series of three allelomorphs for density of black or brown (E_d, E and E_y) is a very interesting one. Castle[7] demonstrated that sooty yellow (black belly and tail) and clear yellow (white belly and tail) differ from black and gray rabbits respectively by the same recessive Mendelian factor. He called the contrasted characters extension and restriction of black. Punnett[8] discovered a new dominant factor in the presence of which rabbits which would otherwise be gray were black. This factor, of course, produced no visible effect in animals which were already black. He called this the density factor. He found it to be inherited independently of the agouti series but completely coupled with the extension factor E. The numerical results of complete coupling are identical with those of multiple allelomorphs. The two terms are useful only in theory. Factors which are partially coupled have no necessary physiological relationship as has been abundantly shown in Morgan's work on Drosophila. But the numerous cases of multiple allelomorphs or complete coupling in mammals apparently all involve physiological relationship.[9] The factors when arranged in the order of dominance determine a linear series of physiological effects. Again, even partial coupling seems to be relatively uncommon in mammals owing presumably to the large number of chromosomes. But at least nine series of multiple allelomorphs are known among them. The main effects of Punnett's density factor fit admirably into the extension, or perhaps better, density series in rabbits. With

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[4] Castle, W. E. 1905. *Carn. Inst. Wash. Pub. No.* 23, 78 pp, and Castle and associates, 1909, *ibid.*

[5] Hurst, C. C. 1905. *Loc. cit.*

[6] Castle, W. E. and Fish, H. D. 1915. *Amer. Nat.*, 49:88–96.

[7] Castle, W. E. and associates. 1909. *Loc. cit.*

[8] Punnett, R. C. 1912. *Jour. Gen.*, 2:21; 1915, *Jour. Gen.*, 5:37–50.

[9] This distinction between complete coupling and multiple allelomorphs was pointed out clearly by Sturtevant in connection with albino series in rabbits, 1913. *Amer. Nat.*, 47:234–238. In the case of the density series discussed here, interpretation as a series of multiple allelomorphs or "polygamous factors" instead of by complete coupling was suggested by Wilson, 1912, 1913, *Sci. Proc. R. Dub. Soc.*

formula $E_yE_yA_bA_b$ there is only feeble development of black and the appearance is sooty yellow. In the presence of the agouti inhibitor E_yE_yAA even this feeble black entirely disappears and the rabbit is clear yellow. On raising the level of production of black by replacing E_y by E, the sooty yellow becomes black (EEA_bA_b) and the clear yellow becomes gray (EEAA), the agouti factor now inhibiting black only in part. On further raising the level to E_d (or ED in Punnett's nomenclature) the black can become no blacker ($E_dE_dA_bA_b$) but the inhibitor in gray rabbits is entirely neutralized and formula E_dE_dAA gives black. This factor is not entirely dominant as heterozygotes may show a few agouti hairs on the nape of the neck giving a color which Punnett calls agouti-black. Among these heterozygotes, Punnett found a difference which seemed to him to eliminate the hypothesis of multiple allelomorphs. According to him EDEd (E_dE on the hypotheses of triple allelomorphs) is agouti black but EDE_yd (or E_dE_y) is black. It is, indeed, surprising to find the yellow factor E_y determining a greater tendency toward black than its allelomorph E. But the anomaly appears equally great to the writer in both theories and so cannot be used as an argument. Further, the figures so far presented do not seem altogether demonstrative on this point. For a critical test it would be necessary to obtain the two heterozygotes (E_dE and E_dE_y) from the same litter and prove a difference in appearance. It may be that either formula may be black or agouti-black depending on subsidiary factors and a comparison of them when derived from different crosses may lead to erroneous results.

CHOCOLATE RABBITS

Punnett also reported on a variation which replaced black by brown in all combinations and is apparently comparable with the brown variations of other rodents. He noted an increase in the amount of yellow in agouti-browns (AAE_dEbb) as compared with agouti-blacks (AAE_dEBB). This is in harmony with conditions in other cases. As in pink-eyed agouti guinea-pigs, the weakening of black by a factor of class 2b permits an extension of yellow although not in so direct a way as reduction of level in a factor of a class $2a_3$ such as in the series E_d, E, E_y just discussed.

The Supposed Law of Compensation

Ralph Waldo Emerson made famous the law of compensation, according to which, Nature always compensates those who are in any way handicapped, and vice versa. Those who have great ability in abstract thinking, it is supposed, will be inferior in ability at concrete problems; those who are slow to learn will be long to remember; those who are weak in arithmetic will be good in history, and those who have beauty will lack brains. The exact methods of modern psychology have so uniformly shown this so-called law to be baseless, that it has long been discredited, and every student knows that, in general, the reverse holds true: that correlation, not compensation, is the law of nature. The man who is quickest to learn will in most cases have the best memory; the man who excels in arithmetic is likely to be above the average in historical erudition; and the best-looking people usually have more than ordinary intelligence. In many years of research, almost no cases have been found which bear out Emerson's generalization; hence it is something of a surprise to find several such cases reported by W. A. McCall of Teachers' College (*School and Society*, 1917, pp. 24-30). He states emphatically, however, that the cases which he reports are exceptional, and do not shake the general rule that superiority in one thing involves superiority in other things. "To him that hath shall be given" is certainly the general law of man's nature.

COLOR INHERITANCE IN MAMMALS

V. The Guinea-pig—Great Diversity in Coat-pattern, Due to Interaction of Many Factors in Development—Some Factors Hereditary, Others of the Nature of Accidents in Development

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Bureau of Animal Industry, Washington, D. C.

THE four series of which dilution (C_d), black (A_b), yellow (E_y) and brown (b) are the recessives have been shown to be inherited independently of each other by Castle[1] who crossed wild *Cavia cutleri* of Peru (CAEB) with a brown-eyed yellow race of the tame guinea-pig, *C. porcellus*, known not to transmit agouti ($C_dA_bE_yb$). He obtained all of the visibly distinct combinations in F_2 in proportions very close to those expected. The pink eye factor (p) is known not to be an allelomorph of any of the others but thorough tests have not yet been made for linkage. White spotting can be combined with any color and so is no doubt inherited independently.

No dominant white is known in guinea-pigs. A type of roan or silvering is common but does not follow simple Mendelian inheritance. A cross between a good roan and self produces young which are usually slightly silvered on the belly. Those in F_2 are also generally slightly silvered and there is no clear-cut segregation. In these silvered guinea-pigs there is not merely an intermingling of colored and white hairs but also an intermediate condition within many hairs. Thus black, dull black, and white hairs (or red, whitish red and white) are found side by side.

THE PIEBALD PATTERN

Some grade of piebald between mere traces of white to the black-eyed white condition is almost universal among tame guinea-pigs. The pattern is exceedingly irregular and generally asymmetrical. The writer has found it exceedingly variable even within single litters after sixteen generations of the closest inbreeding and there can be no question that a very large part of the variability is not represented in the germ-plasm. This is further demonstrated by the low correlations (.15 to .30) between parent and offspring or between brothers in stock bred at random as regards pattern. The average quantity of white, nevertheless, seems to be much more strongly inherited than the pattern in which it is disposed. The latter is inherited to some extent, however, as MacCurdy and Castle[2] were able by selection to

AGOUTI-COLORED CAVIES

Cavia cutleri Bennett—SCAEBP. *Cavia porcellus* Linn—SCAEBP. *Cavia rufescens* Lund—SCA_rEBP (*Patterns of black and red or yellow*)

$1a_1$	—	
$1a_2$	S,s	s—piebald
$1a_3$	—	
1b	C, C_d, C_r, C_a	C_d—dilute (sepia and yellow), C_r—red-eyed dilute (sepia and white), C_a—albino
$2a_1$	A, A_r, A_b	A_r—ticked-bellied agouti, A_b—black
$2a_2$	E, E_p, E_y	E_p—tortoise, E_y—yellow
$2a_3$	—	
2b	B,b	b—brown-eyed brown agouti (brown and red)
	P,p	p—pink eyed agouti (pale brown and red)

Classification explained in paper on the mouse, JOURNAL OF HEREDITY, 8:373, August, 1917.

[1] Castle, W. E. 1916. *Carn. Inst. Wash. Pub.*, No. 241, part 1, 55 pp.
[2] MacCurdy, H. and Castle, W. E. 1907. *Carn. Inst. Wash. Pub.*, No. 70, 50 pp.

increase the extent to which a certain relatively uncommon pattern, the colored nose spot, was produced. A similar differentiation in regard to pattern has taken place automatically among several families of very closely inbred stocks which the writer is studying. The very large amount of variation in both amount and pattern make Mendelian analysis difficult and no unit differences have been thoroughly demonstrated. The writer has, however, obtained rather clear indications of segregation of a recessive unit factor for piebald in crosses with a self-colored feral stock and with a certain inbred stock which is roan but not piebald. Other nearly self-colored inbred stocks behave very differently. That piebald is inherited independently of the roan variation is shown by a cross of a uniformly piebald stock with the roan, but not piebald, stock mentioned above. Several, at least, of the young were solid black, lacking both piebald and roan, while the others approached this condition very closely.

ALBINO SERIES OF ALLELOMORPHS

Albino guinea-pigs may show enough black sootiness in the fur to bring out clearly an underlying piebald pattern. They generally have black points and thus correspond best with Himalayan rabbits. Castle[3] found albinism clearly recessive. Later[4] he found a peculiar series of varieties in Peru which seems to be unknown to American fanciers. These had dark red eyes and white in place of yellow in the fur but a fairly intense black. An allelomorph of albinism proved to be responsible for their condition. The same variation seems to have been obtained by Blaringhem and Prévot[5] from South America and they were much puzzled by its mode of inheritance. The writer found another allelomorph in the series in the common dilute guinea-pigs in which intense yellow or red is reduced to a lighter yellow or cream and black is slightly reduced. Certain peculiar relations of dominance within the series of four allelomorphs were also found.[6] These were discussed in the first paper of this series. (JOURNAL OF HEREDITY 8:224-235, May, 1917.)

THE AGOUTI PATTERN

Castle[7] early found the agoutis to differ from the black and brown varieties lacking this pattern by a unit dominant factor. In ordinary agouti guinea-pigs the belly appears yellow while the back is black, each hair having a yellow band. The width of the yellow band is quite variable and when narrow, black may invade the base of the hair on the belly. As in other cases, such variations may be due either to variations in the agouti factor itself or to independent factors. In this case both have been demonstrated. Thus the yellow band increases greatly when black is weakened by the action of the pink eye factor. The same is true in the brindle spots usually found in tortoise-shells. Thus factors p and E_p can be looked on as modifiers of agouti. Probably all factors of class 2 and perhaps some of class 1 in a more indirect way produce variations in the width of the agouti band. This effect seems to be through weakening or reducing the amount of black to be inhibited by the agouti factor. A similar visible effect is produced by varying the strength of the inhibiting agent itself and this is presumably the mode of action of an allelomorph of the factors for guinea-pig agouti and nonagouti found by Detlefsen[8] in hybrids between the guinea-pig and *C. rufescens*, a Brazilian cavy. The writer[9] was able to confirm the existence of these three allelomorphs but could find no such difference between the

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[3] Castle, W. E. and Allen, G. M. 1903. *Proc. Am. Ac. Arts and Sci.*, 38:603.
[4] Castle, W. E. 1914. *Amer. Nat.*, 48:65–73.
[5] Blaringhem and Prévot. 1912. Quoted by Lang, 1914, *Experimentelle Vererbungslehre.*
[6] Wright, S. 1915. *Amer. Nat.*, 49:140–148, 1916, *Carn. Inst. Wash. Pub.*, No. 241, part ii, 101 pp.
[7] Castle, W. E. 1905. *Carn. Inst. Wash. Pub.*, No. 23, 78 pp. 1907. *Sci. N. S.*, 25:151–153. 1913. *Carn. Inst. Wash. Pub.*, No. 179, p.1–10, etc.
[8] Detlefsen, J. 1914. *Carn. Inst. Wash. Pub.*, No. 205, 134 pp.
[9] Wright, S. 1916. *Loc. cit.*

agouti of another wild species *C. cutleri* and the guinea-pig agouti. *Cavia rufescens* itself does not differ as much from the agouti guinea-pig or *C. cutleri* as do its hybrids. It has, however, a somewhat darker appearance owing to narrow yellow bands in the hair. In the hybrids with the guinea-pig the distinction between the agouti of *C. rufescens* and that of the guinea-pig in most cases increased as the amount of guinea-pig blood was increased. In many cases the young were almost indistinguishable from blacks which is never the case with the yellow-bellied guinea-pig agoutis. This effect was especially noticeable when the guinea-pig parents were of a certain exceedingly intense black stock. The fact that all stocks of guinea-pigs with factor C show a more intense black than the pale slaty color of the wild species (which also can be shown to possess factor C) suggests that guinea-pigs have acquired through selection a much higher level of factors in class $2a_3$. Thus *C. rufescens*, with a lower level of both the agouti factor and the density of black, shows about the same net result in pattern as the guinea-pig agouti. As noted above, the Peruvian cavy, *C. cutleri*, apparently possesses the same agouti factor as guinea-pigs. It follows that the dark gray of *C. rufescens* and the light gray of *C. cutleri* differ by a unit Mendelian factor, a thing not demonstrated for many specific differences among animals. It should be added, however, that there is considerable variation within *C. rufescens* and both allelomorphs may be present as suggested by Castle.

TORTOISE SERIES OF ALLELOMORPHS

Self red or yellow differs from the colors which show black or brown in the fur (except the sooty reds) by a unit factor as shown by Castle,[10] and confirmed by later workers.[11] Castle showed that reds might be homozygous or heterozygous for the agouti factor or not transmit it at all (E_yE_yAA, $E_yE_yAA_b$ and $E_yE_yA_bA_b$) a point which differentiates the red and yellow of guinea-pigs completely from red and yellow in mice. Recently Ibsen[12] has announced that the common tortoise-shells (black and red spotted) contain an allelomorph between complete extension of dark colors and the complete restriction found in reds and yellows. While he has not yet published the evidence, his series, E, E_p and E_y, is adopted here provisionally. The writer has obtained results, in experiments made to test the hypothesis, which seem to bear it out although not yet demonstrating it exhaustively. The tortoise-shell pattern like the piebald may vary from a very small amount of red to nearly self red and it is very probable that animals with formula E_pE_p may occasionally overstep both limits. As in piebalds, asymmetry is very common and much of the variation is doubtless merely developmental. There are not only variations in the extent and localization but also in the intensity of the black spots. Areas of the fur on the same animal may be wholly intense black (or agouti, brown, etc.) or wholly red or intermediate, a brindle of black and red, in which the black is of reduced density. In some cases, instead of a brindle, the black and red become so thoroughly blended in the hairs that a brown spot results. In this way animals which are both tortoise and piebald are occasionally not merely tri-colored but four-colored with solid spots of black, brown and red on a white ground.

PIEBALD AND TORTOISE PATTERNS

There is some similarity in the patterns of piebald and tortoise guinea-pigs. The differences, however, are no less striking so that even in red-eyed dilutes (C_rC_r) in which both patterns are in white, they can often be distinguished. In piebalds the pattern is typically one of large spots or blotches of color on a white ground. There are certain more or less definite spot centers as the eyes and ears, as noted by Castle[13]

[10] Castle, W. E. 1905. *Ibid.*, 1907, *loc. cit.*
[11] See for example, Sollas, I. B. J. 1909. *Rept. Evol. Com. R. Soc. London*, 5:51–79.
[12] Ibsen, H. L. 1916. *Genetics*, 1:287–309.
[13] Castle, W. E. 1905. *Loc. cit.*

and Allen.[14] Spots on the back are usually large—seldom less than one-third the total length of the back if present at all. There is little or no symmetry about the mid-dorsal line and spots cross freely from one side to the other. Certain kinds of spots are unusual except in particular stocks in which they may be common. Such are a nose spot and a small rump spot. Spots seldom cross the mid-line of the belly but are sharply truncated by the latter, a fact which strongly suggests that the pattern is determined at a very early stage of the embryo when the two sides of the belly are as far from each other as possible. In animals which are largely colored the location of the white areas is quite characteristic. Thus white feet, white areas on the nose and mid line of the face, on the throat, narrow white streaks along the under surface of the legs and along the middle of the belly are especially common.

In tortoises the relation of red to black is more nearly coördinate than is the relation of white to color in piebalds, where, as just noted, it is distinctly a case of white gaps between colored spots. The pattern is highly irregular but a tendency may often be noted to an arrangement of the colors in relatively narrow alternate bands across the back. The mid-line of the belly breaks the continuity of the pattern on each side as sharply as in piebalds.

INTERRELATIONS

When both patterns, piebald and tortoise, are combined,[15] it becomes obvious that they are in some way related in development. The spots are, as a rule, either entirely black, entirely red or entirely a kind of brindle or brown. This, of course, would not be the case if the patterns were simply laid over one another. Again, there are certain peculiarities within the spots which prove an interrelation. Brindle spots generally show more dark color at the center and thus vary from nearly black with a brindle border to nearly red with a brindle center. Another fact which shows an interrelation of piebald and tortoise is a curious sex difference. Males, in general, show slightly more color as opposed to white and also more black (or agouti, etc.) as opposed to red than their sisters. It is not true in general, however, that increase in white means increase in ratio of red to black. In a given stock the average ratio of red to black is remarkably constant for all grades of white. In attempting to explain the relations it is also to be noted that the presence of piebald seems to affect the tortoise pattern but not the reverse. The localization of white seems to be the same whether the spots are all black, all red or some black and others red. The tortoise pattern, on the other hand, loses its tendency to narrow transverse belts and conforms itself to the shape of the colored spots. It may be added that it is easy to make sketches of piebalds and tricolors but tortoises generally have such a jumble of small spots and irregular brindling that a satisfactory sketch is difficult to make.

NO SIMPLE EXPLANATION

It is evident that no simple explanation of the determination of tortoise, piebald and tricolor patterns can be looked for. In piebalds there seems to be involved some substance essential for color production which has such a relation to the latter that above a certain critical level maximum color production can take place, below it, none whatever. Hereditary factors and, perhaps, also environmental conditions determine the general level in an animal while various causes, hereditary or otherwise, acting in development raise or lower this level in different parts of the coat, and so make possible a pattern. In tortoise there seems to be essentially the same situation with respect to something necessary for the production of black, except that the

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[14] Allen, G. M. 1914. *Amer. Nat.*, 48:385–412; 467–484; 550–566.

[15] Tricolors have been discussed by W. E. Castle, 1912, *Amer. Nat.*, 46:437–440; A. Hagedoorn, 1912, *Amer. Nat.*, 46:682; Goodale and T. H. Morgan, 1913, *Amer. Nat.*, 47:321; and H. Ibsen, 1916, *loc. cit.*

critical level is not so sharp. There is a zone between red and black in which brindle or brown may appear. The variation in both patterns from a high degree of symmetry with respect to the parts of the body to a condition of asymmetry which almost wholly disregards the latter, points to a complexity of causes. Perhaps time is a factor—pattern differentiation, which arises very early, tending to be unrelated with the later symmetrical differentiation of the embryo and vice versa. In this connection it is interesting to note that in some piebald mammals as rats, rabbits and Hereford cattle there is a high degree of symmetry, while others as mice and Holstein cattle approach closer to the chaotic patterns of guinea-pigs.

In the relations of the patterns to each other, there are all variations from independence to obvious coördination. The main genetic factors, as S and E_p, seem to be inherited independently, other factors, of which sex is one, act on both patterns, perhaps through some general influences on metabolism, and doubtless there are both independent and common nongenetic factors which act during development. Among the latter must be considered the possibility that mutations in the hereditary material received from the zygote may take place at random in the somatic cells producing spots in the groups of cells which descend from them. Differentiation due to such a cause would produce a mosaic of coördinate black, red and white spots. On the other hand, the general relations of color to white and also of black to red in the case of a dark spot with a red border surrounded by white suggest the radiation of some influence from centers in the skin, with simultaneous effects on both the level for pigment production and for black.

Summing up, it appears that coat pattern in guinea-pigs, and doubtless other animals as well, must be determined by a complex of causes of very diverse kinds. There are hereditary factors of various sorts and factors which are of the nature of accidents in development. There are factors which affect the extent of pattern and others which determine its localization. Of the latter some relate the pattern to the axis of symmetry and organs of the body while others are random in their incidence. Some factors affect only the tortoise pattern in one way or another, or only the piebald pattern, while others have a simultaneous influence on both. The result is such a diversity of pattern among tri-colors that a rough sketch will identify almost any animal in a stock of a thousand.

OTHER VARIATIONS OF GUINEA-PIGS

Black sootiness often appears in the red or yellow parts of the fur of guinea-pigs as they grow older. This sootiness is especially conspicuous in pale creams and in whites resulting from extreme dilution of red (C_rC_r). As such sootiness never appears in the white parts of piebalds, its presence gives another means of distinguishing white spots which represent reduced red from piebald white, besides the different appearance mentioned above. The mode of inheritance of black sootiness is unknown.

Two independent Mendelian factors are known which dilute black very uniformly throughout the skin, fur and eyes, but have no influence on the intensity of red. The first of these to be known[16] changes black to brown, ordinary agouti to cinnamon, black and red tortoise to brown and red tortoise, black-eyed red to brown-eyed red, etc. The other is responsible for a series of pink-eyed colored varieties unknown to the fanciers. The latter was found by Castle[17] in one of the South American stocks which also furnished the red-eyed dilution. The eye generally shows traces of pigment. Black in the skin and fur is reduced to a very pale brown, much paler than in the brown varieties while red is unaffected in intensity. Both the brown factor, b, and the pink eye factor, p, are Mendelian recessives and both obviously belong in class 2b.

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[16] Castle, W. E. 1907. *Sci. N. S.*, 26:287–291; 1908, *Sci. N. S.*, 28:250–252.
[17] Castle, W. E. 1914. *Loc. cit.* 1916. *Loc. cit.*

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